Network Systems Science & Advanced Computing

Biocomplexity Institute & Initiative

University of Virginia

Estimation of COVID-19 Impact in Virginia

November 2nd, 2022

(data current to October 28th – November 1st)

Biocomplexity Institute Technical report: TR BI-2022-1777

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About Us

- Biocomplexity Institute at the University of Virginia
  - Using big data and simulations to understand massively interactive systems and solve societal problems
- Over 20 years of crafting and analyzing infectious disease models
  - Pandemic response for Influenza, Ebola, Zika, and others

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Overview

- **Goal**: Understand impact of COVID-19 mitigations in Virginia
- **Approach:**
  - Calibrate explanatory mechanistic model to observed cases
  - Project based on scenarios for next 4 months
  - Consider a range of possible mitigation effects in "what-if" scenarios
- **Outcomes:**
  - Ill, Confirmed, Hospitalized, ICU, Ventilated, Death
  - Geographic spread over time, case counts, healthcare burdens

Key Takeaways

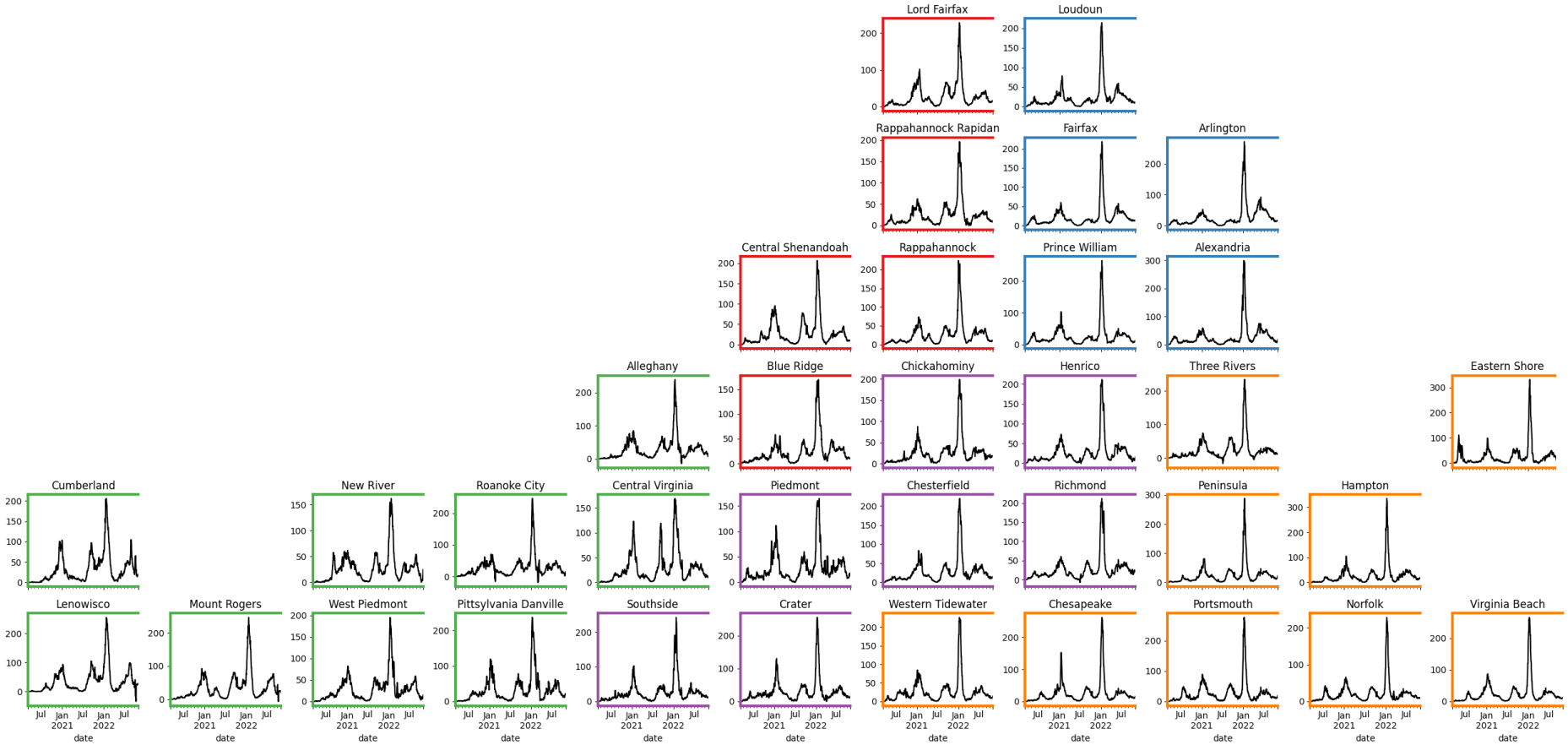
Projecting future cases precisely is impossible and unnecessary.
Even without perfect projections, we can confidently draw conclusions:

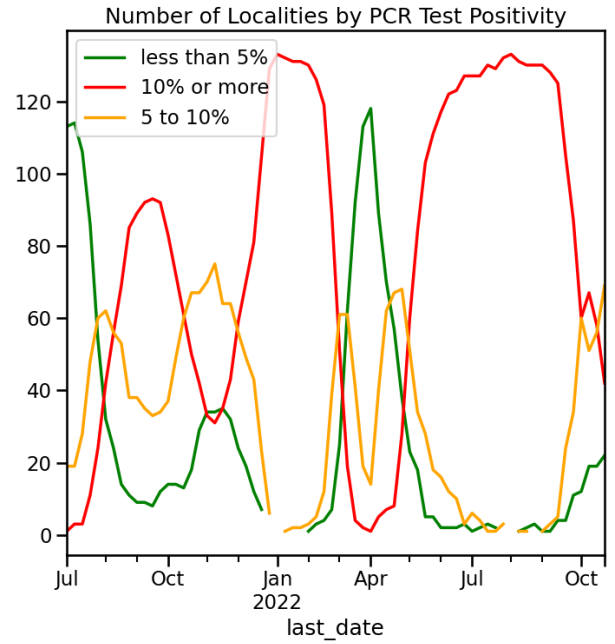
- **Case rates continue their decline, hospitalizations continue decline, though the rate of decline is slowing**
- VA weekly case rate is back up to 90/100K from 81/100K
  - US weekly case rate is flat remaining at 74 per 100K from 74 per 100K
- VA hospital occupancy (rolling 7 day mean of 472 also slightly up from 455 a week ago) has continued to decline
  - Influenza hospitalization shows a rapid increase with over 100 hospitalizations in the last week
- Projections anticipate continued plateau with increases in cases and hospitalizations in coming weeks
  - Rebounds due to seasonal forces and/or novel sub-variants in the coming months could be significant
- Model updates:
  - Modified Booster Scenarios: Current pace (included in all scenarios) with comparisons between Optimistic rollout and a more Pessimistic where vaccination halts at current levels
  - Variant X candidates seem to be growing (BQ.1.1 and XBB among others), 50% prevalence adjusted to Nov 12th

The situation continues to change. Models continue to be updated regularly.

Situation Assessment

Case Rates (per 100k) and Test Positivity





County level RT-PCR test positivity

Green: <5.0% (or <20 tests in past 14 days)

Orange: 5.0%-10.0% (or <500 tests and <2000 tests/100k and >10% positivity over 14 days)

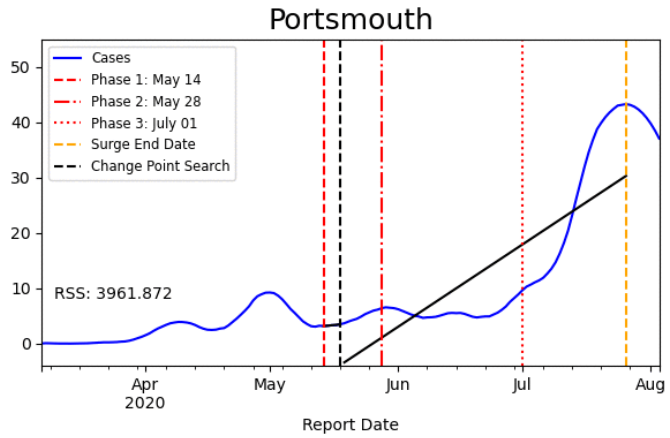
Red: >10.0% (and not "Green" or "Yellow")

District Trajectories

Goal: Define epochs of a Health District's COVID-19 incidence to characterize the current trajectory

Method: Find recent peak and use hockey stick fit to find inflection point afterwards, then use this period's slope to define the trajectory

Hockey stick fit

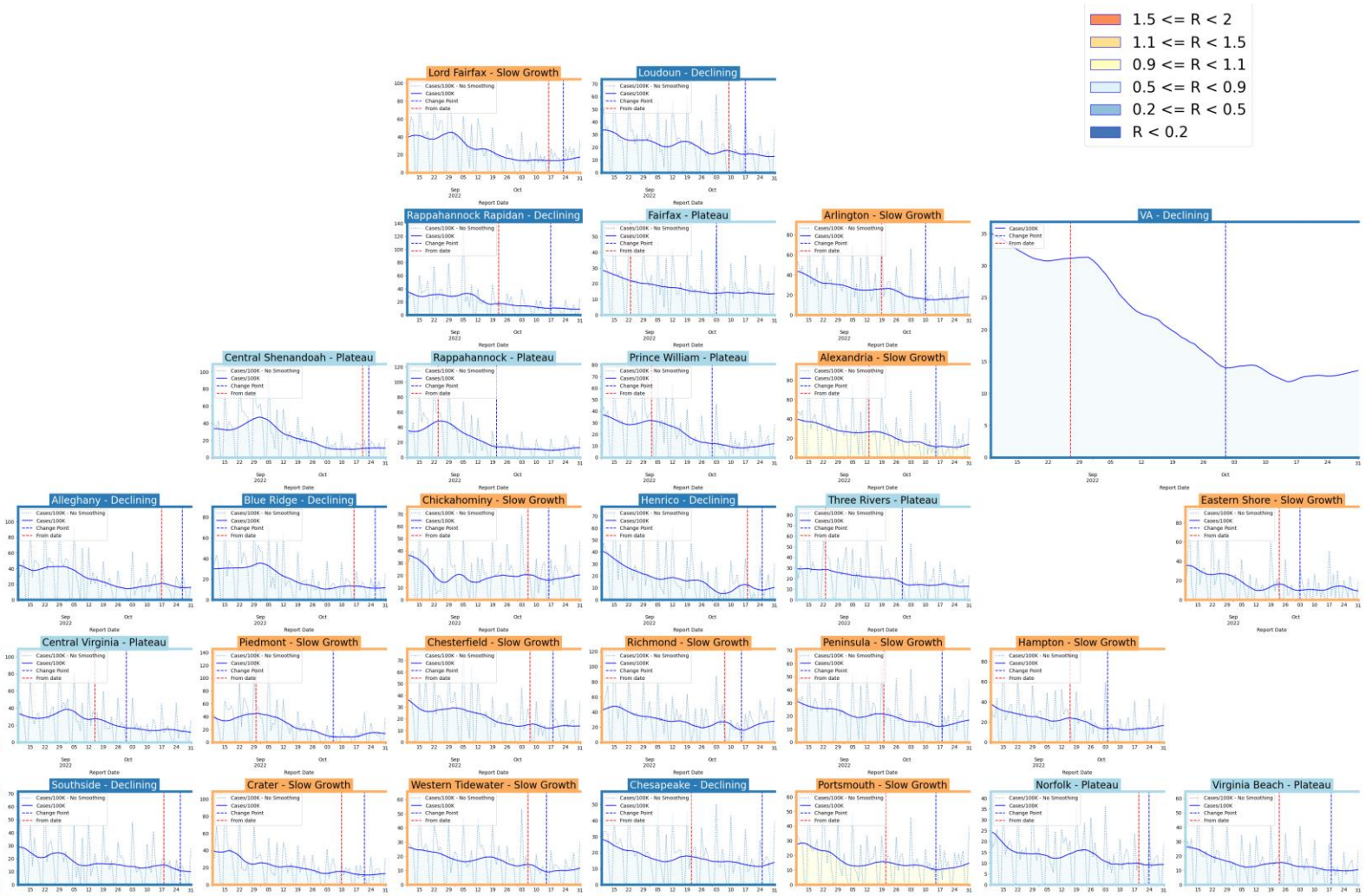


Trajectory	Description	Weekly Case Rate Slope (per 100k)	Weekly Hosp Rate Slope (per 100k)
Declining	Sustained decreases following a recent peak	slope < -0.88/day	slope < -0.07/day
Plateau	Steady level with minimal trend up or down	-0.88/day < slope < 0.42/day	-0.07/day < slope < 0.07/day
Slow Growth	Sustained growth not rapid enough to be considered a Surge	0.42/day < slope < 2.45/day	0.07/day < slope < 0.21/day
In Surge	Currently experiencing sustained rapid and significant growth	2.45/day < slope	0.21/day < slope

District Case Trajectories – last 10 weeks

Status	Number of Districts	
	Current Week	Last Week
Declining	9	(17)
Plateau	8	(8)
Slow Growth	17	(8)
In Surge	1	(2)

Curve shows smoothed case rate (per 100K)
Trajectories of states in label & chart box
Case Rate curve colored by Reproductive number



District Hospital Trajectories – last 10 weeks

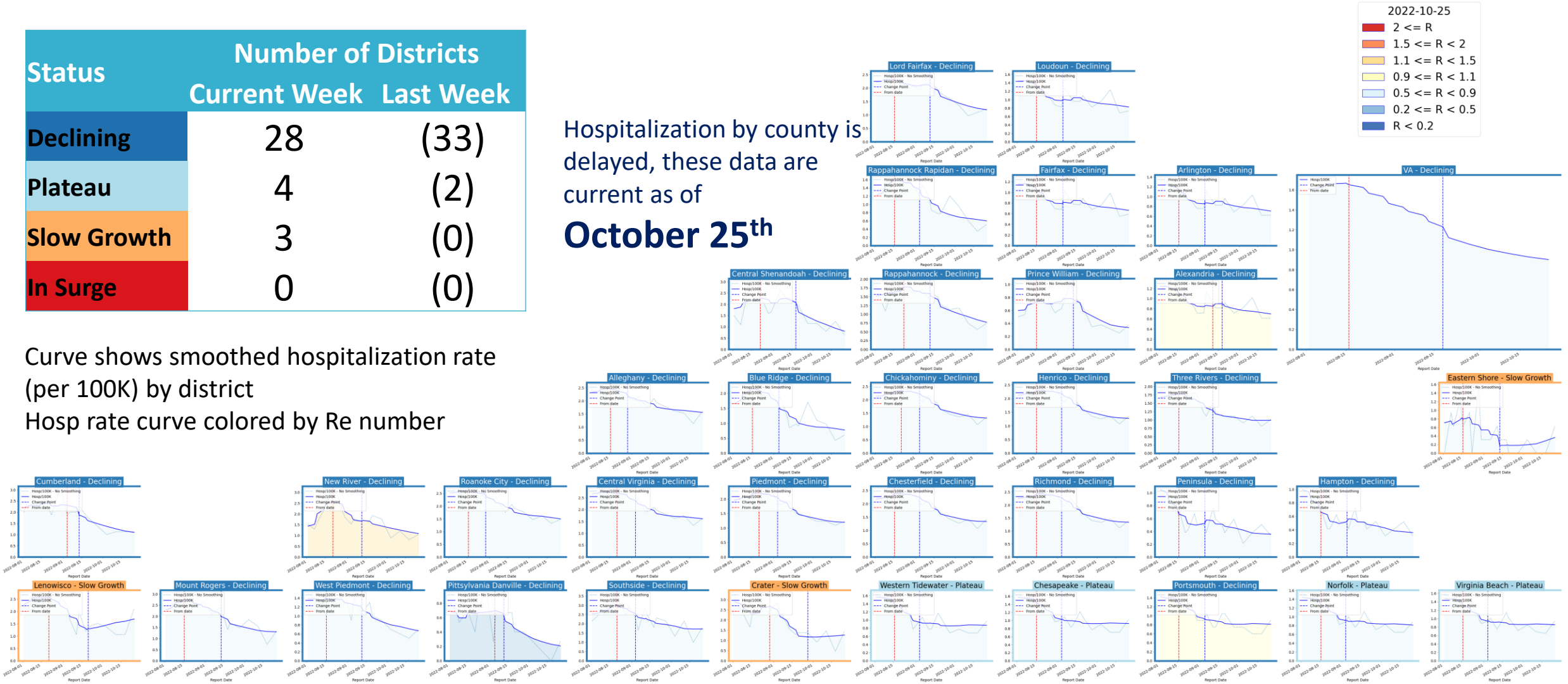
Status	Number of Districts	
	Current Week	Last Week
Declining	28	(33)
Plateau	4	(2)
Slow Growth	3	(0)
In Surge	0	(0)

Hospitalization by county is delayed, these data are current as of

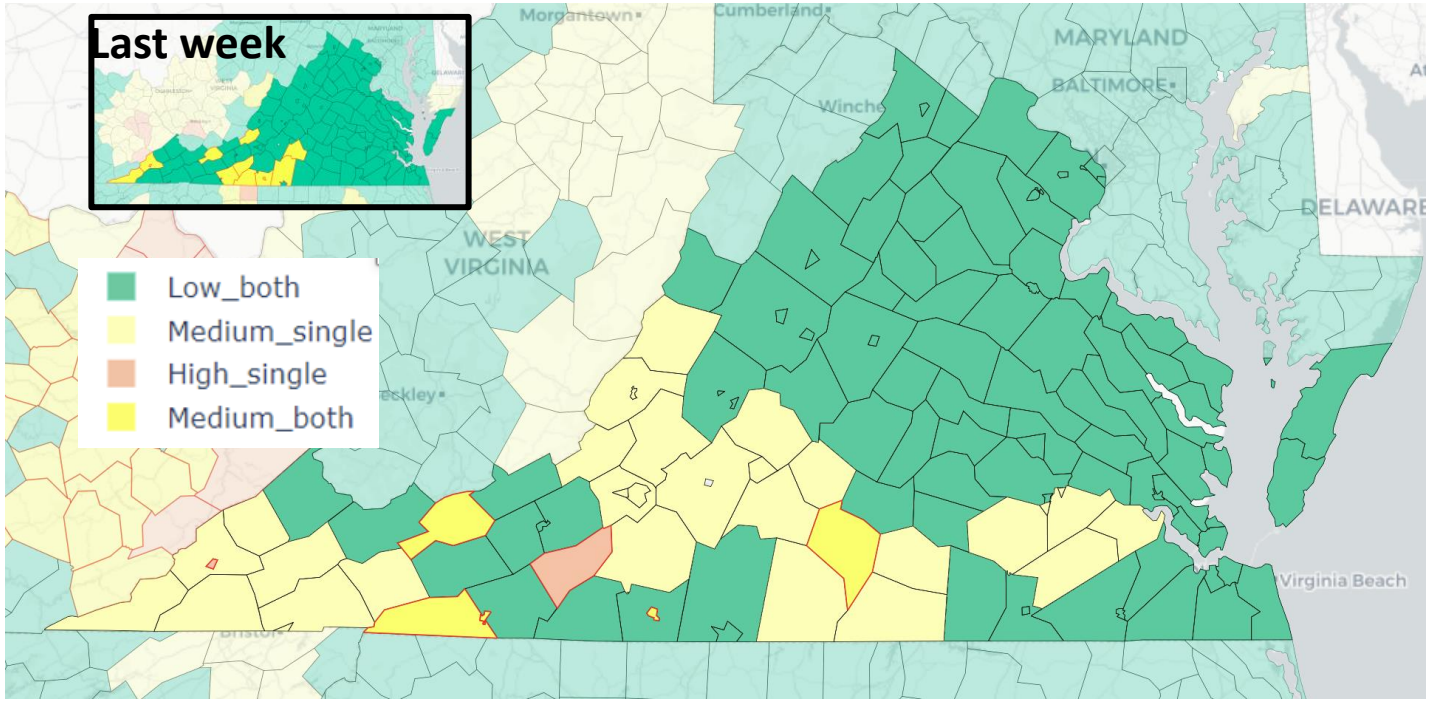
October 25th

Curve shows smoothed hospitalization rate (per 100K) by district

Hosp rate curve colored by Re number



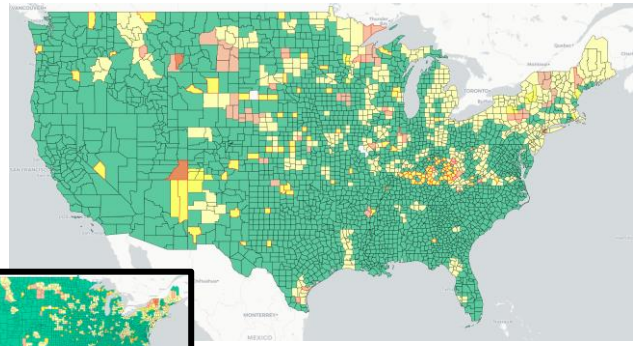
CDC's COVID-19 Community Levels



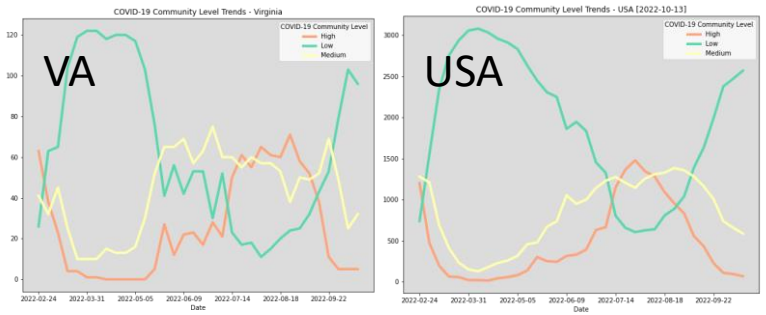
Red outline indicates county had 200 or more cases per 100k in last week

Pale color indicates either beds or occupancy set the level for this county

Dark color indicates both beds and occupancy set the level for this county



Last week



COVID-19 Community Levels – Use the Highest Level that Applies to Your Community				
New COVID-19 Cases Per 100,000 people in the past 7 days	Indicators	Low	Medium	High
Fewer than 200	New COVID-19 admissions per 100,000 population (7-day total)	<10.0	10.0-19.9	≥20.0
	Percent of staffed inpatient beds occupied by COVID-19 patients (7-day average)	<10.0%	10.0-14.9%	≥15.0%
200 or more	New COVID-19 admissions per 100,000 population (7-day total)	NA	<10.0	≥10.0
	Percent of staffed inpatient beds occupied by COVID-19 patients (7-day average)	NA	<10.0%	≥10.0%

The COVID-19 community level is determined by the higher of the new admissions and inpatient beds metrics, based on the current level of new cases per 100,000 population in the past 7 days

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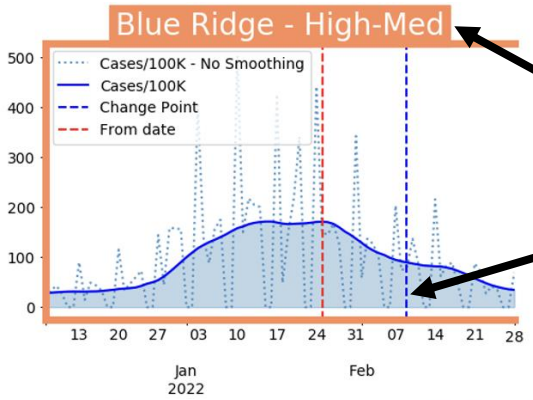
Data from: CDC Data Tracker Portal

District Trajectories with Community Levels

Community Level (Title Color)
- High
- High-Med
- Med-High
- Medium
- Med-Low
- Low-Med
- Low

Curve shows smoothed case rate (per 100K)
CDC's new Community Level aggregated to district level in label & chart box color
Case Rate curve colored by Trajectory

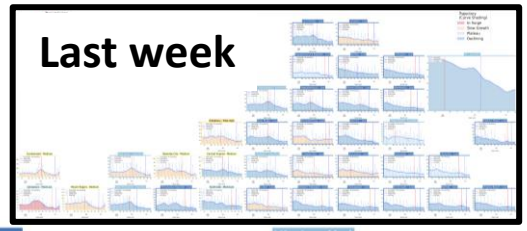
Trajectory (Curve Shading)
- In Surge
- Slow Growth
- Plateau
- Declining



District's Aggregate Community Level

Aggregate level a simple mean of all levels for counties in district

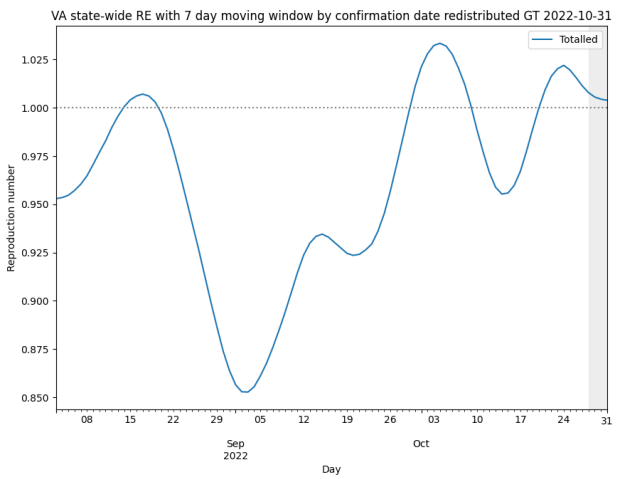
Case rate Trajectory

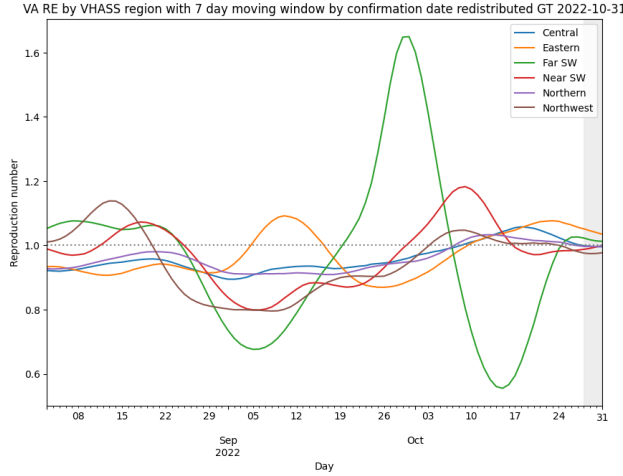


Estimating Daily Reproductive Number –
Redistributed gap

October 31st Estimates

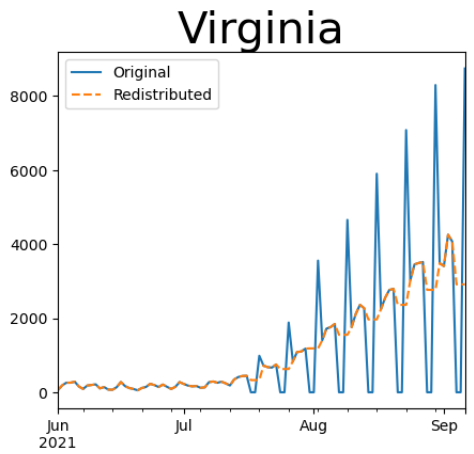
Region	Date Confirmed R_e	Date Confirmed Diff Last Week
State-wide	1.005	0.115
Central	0.990	0.002
Eastern	1.037	0.079
Far SW	1.018	0.516
Near SW	0.997	0.256
Northern	0.996	0.041
Northwest	0.979	0.078





Skipping Weekend Reports & holidays biases estimates

Redistributed "big" report day to fill in gaps, and then estimate R from "smoothed" time series



Methodology

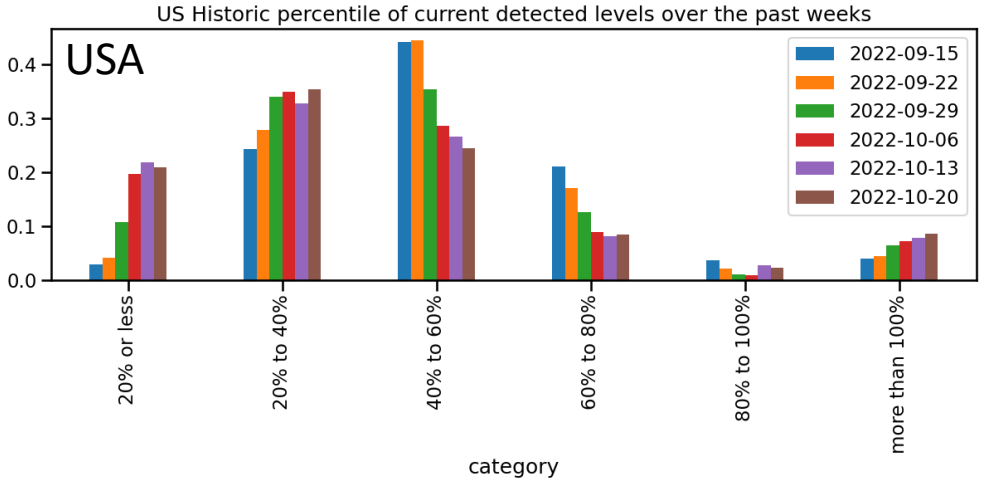
- Wallinga-Teunis method (EpiEstim[1]) for cases by **confirmation date**
- Serial interval: updated to discrete distribution from observations (mean=4.3, Flaxman et al, Nature 2020)
- Using Confirmation date since due to increasingly unstable estimates from onset date due to backfill

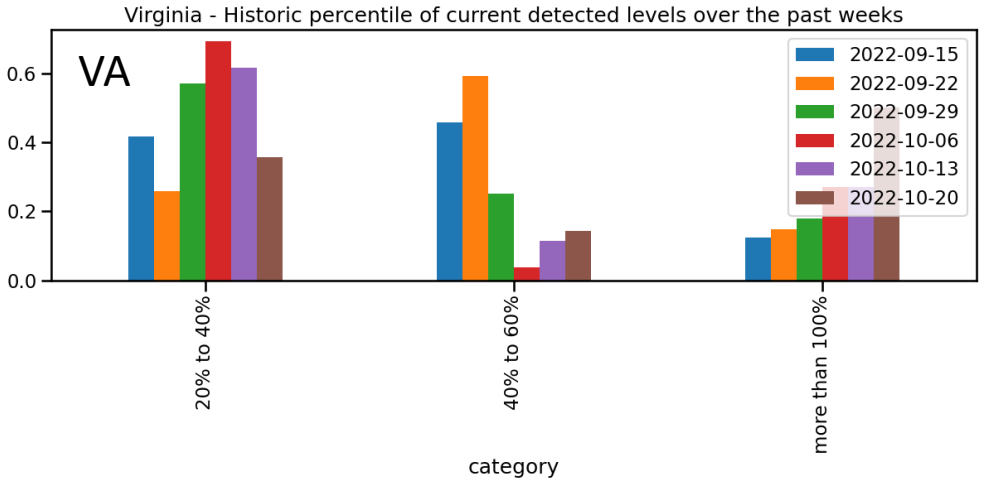
1. Anne Cori, Neil M. Ferguson, Christophe Fraser, Simon Cauchemez. A New Framework and Software to Estimate Time-Varying Reproduction Numbers During Epidemics. American Journal of Epidemiology, Volume 178, Issue 9, 1 November 2013, Pages 1505–1512, https://doi.org/10.1093/aje/kwt133

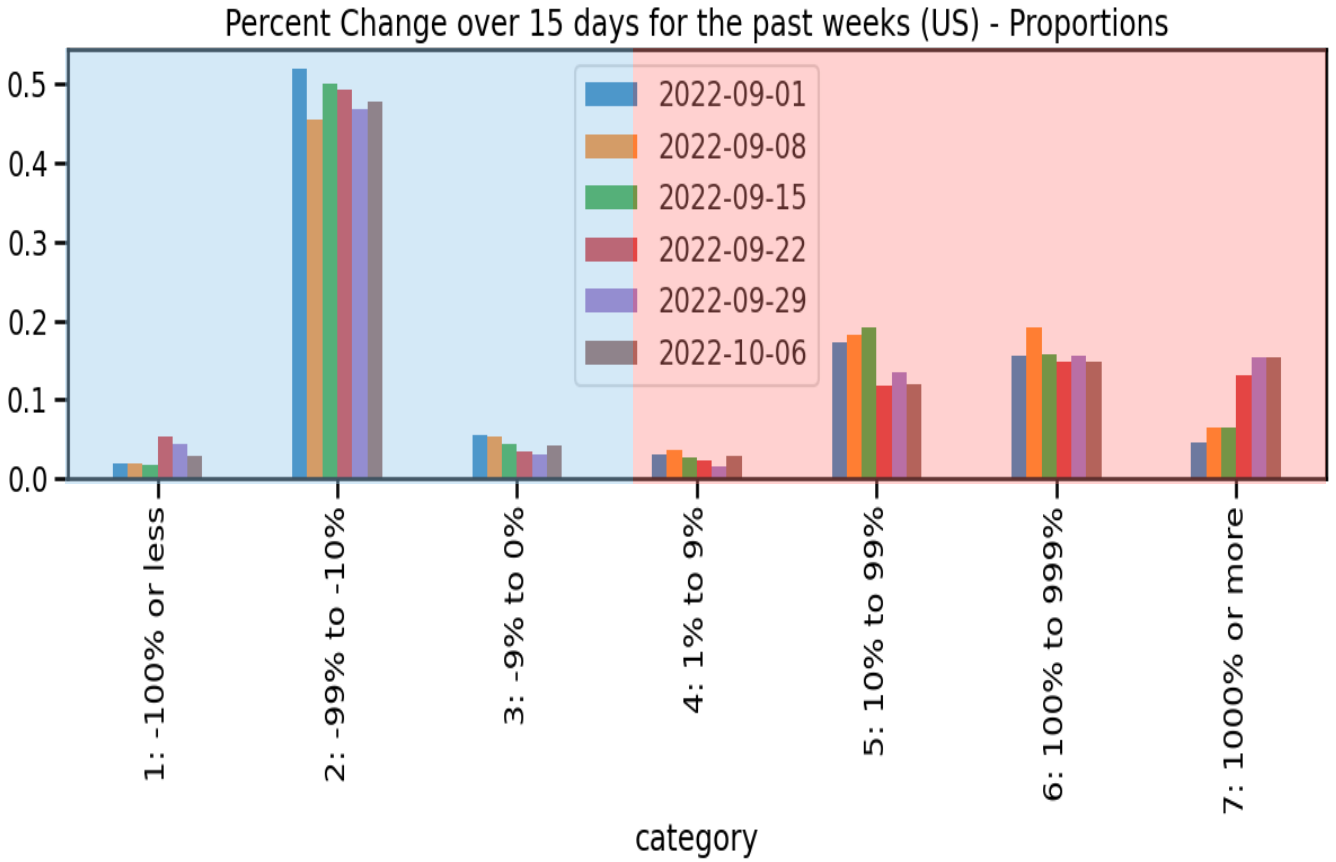
Wastewater Monitoring

Wastewater provides a coarse early warning of COVID-19 levels in communities

- Overall in the US, there is an increase in sites with increased levels of virus compared to 15 days ago
- Current virus levels are at or exceeding max of previous historical levels, has slowed, though more sites are entering upper quintiles





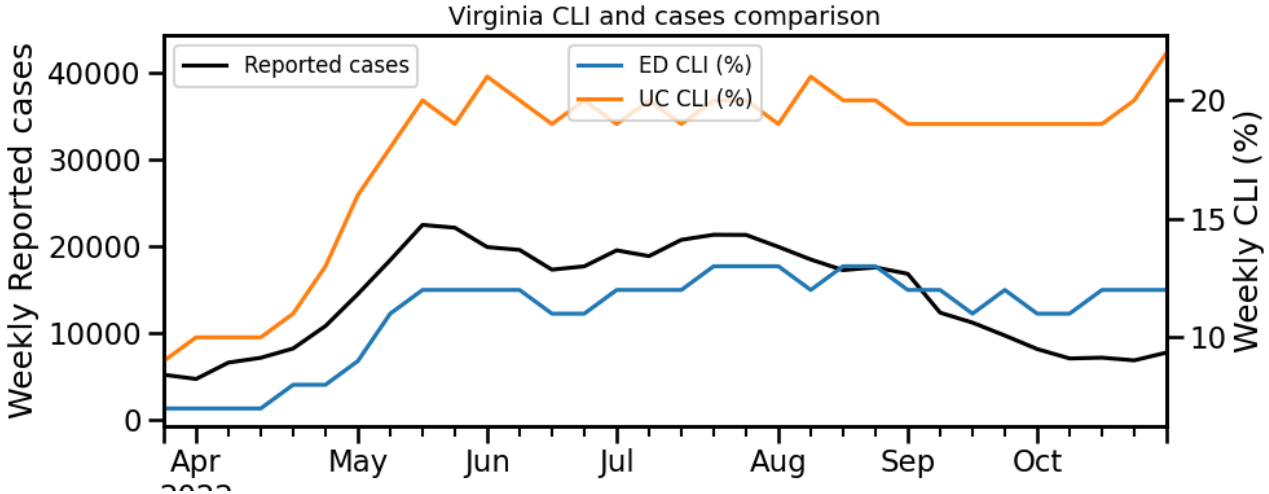


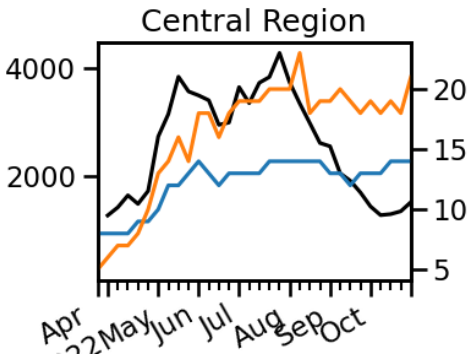
Data Source: [CDC Data Tracker]

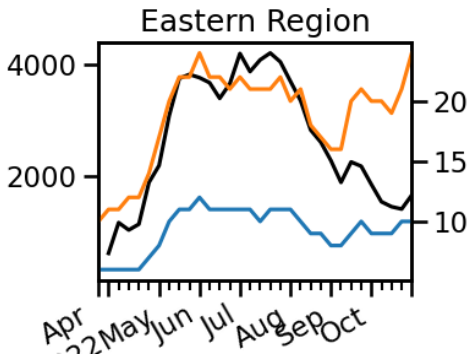
COVID-like Illness Activity

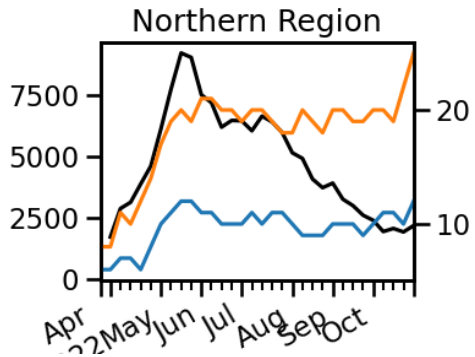
COVID-like Illness (CLI) gives a measure of COVID transmission in the community

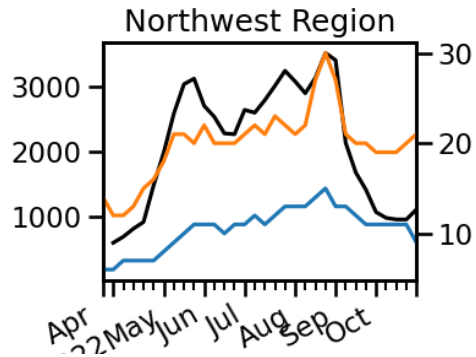
- Emergency Dept (ED) based CLI is more correlated with case reporting
- Urgent Care (UC) is a leading indicator but prone to some false positives
- **After 5 months of plateau UC CLI has experienced 2 weeks of growth to highest level since the initial Omicron waves**

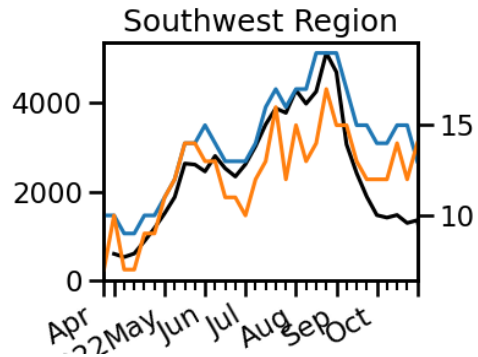










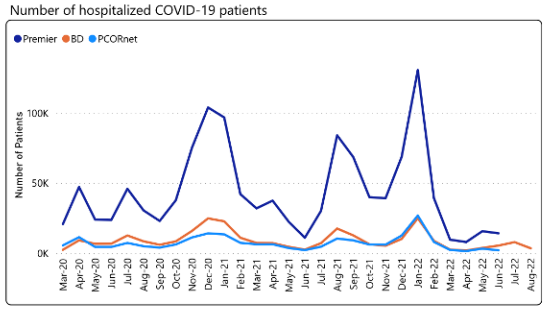


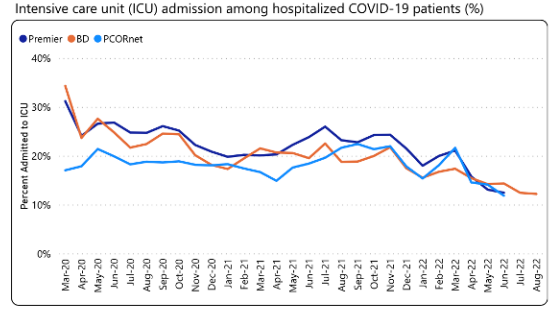
Hospitalizations and Severe Outcomes

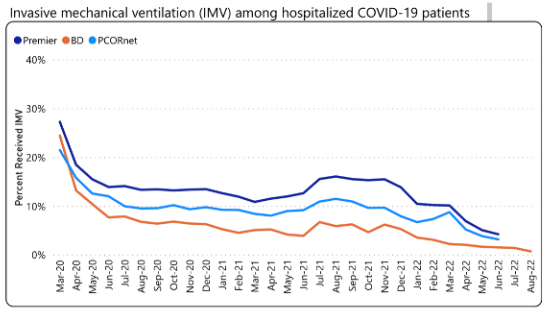
Data Source: [CDC Data Tracker]

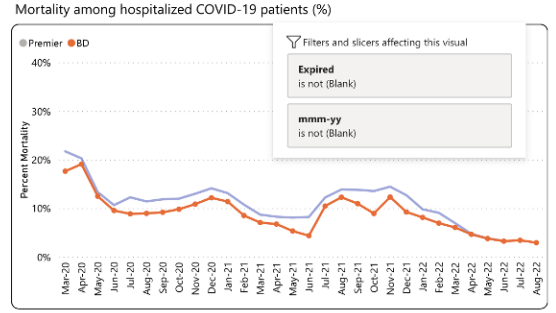
Proportion of most severe outcomes decreasing among those who are hospitalized

- ICU has declined from ~20% of hospitalized to nearly 10% since initial Omicron wave
- Also seen across all age-groups
- Similar levels of decline seen in VA, but recent weeks show a shift towards more ICU and more ventilation

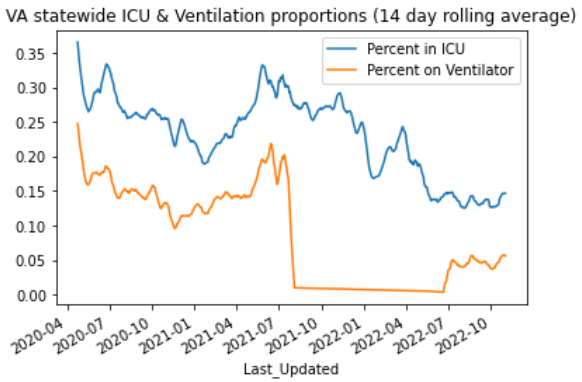




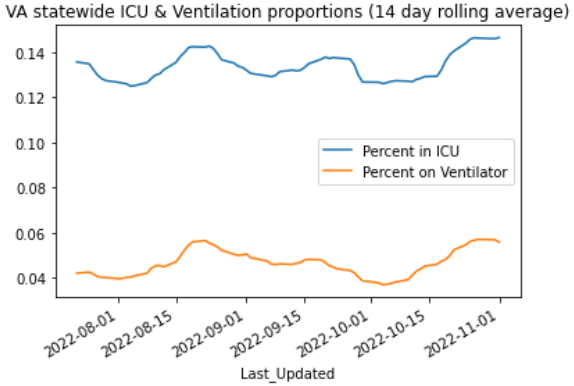




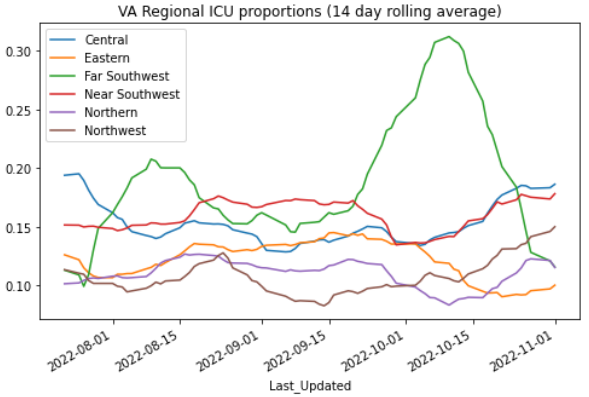
Virginia-wide – full pandemic



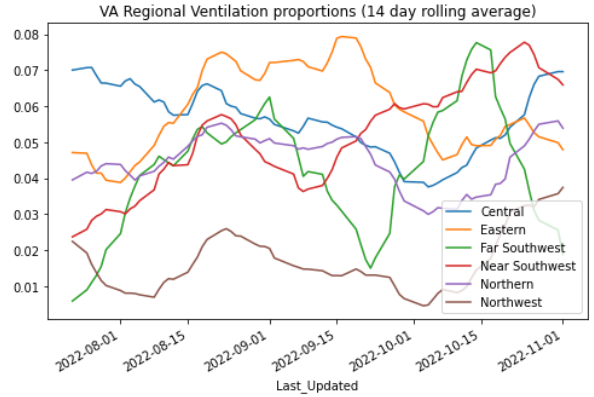
Virginia-wide – recent



Virginia Regional ICU percent



Virginia Regional Ventilation %



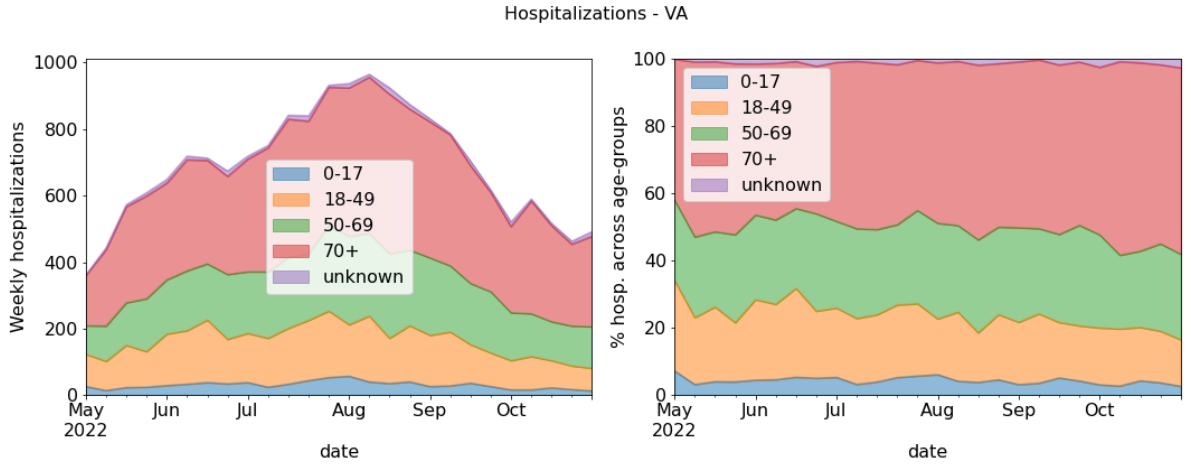
Hospitalizations in VA by Age

Age distribution in hospitals relatively stable

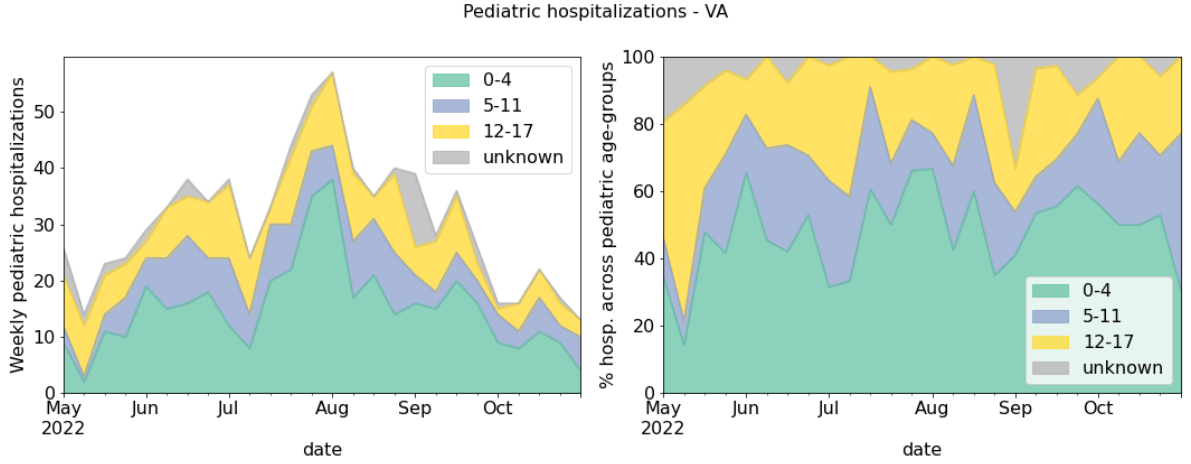
- Recent change in pediatric hospitalizations, though not higher yet than in previous months

Note: These data are lagged and based on hospital reporting HHS

Virginia Hospitalizations by Age (all ages)



Pediatric Hospitalizations by Age (0-17yo)

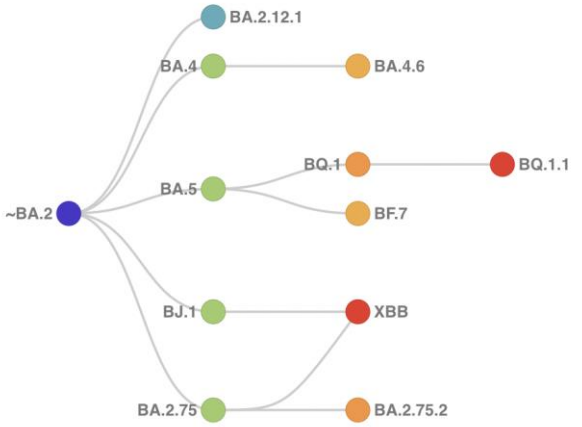


Data Source: Delphi and HHS

SARS-CoV2 Variants of Concern

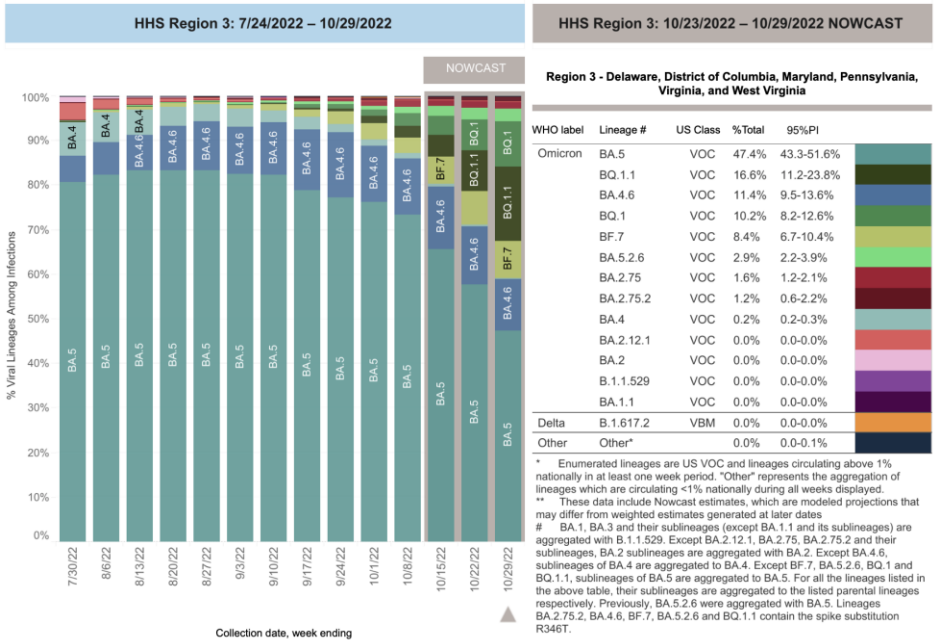
Emerging variants have potential to continue to alter the future trajectories of pandemic and have implications for future control

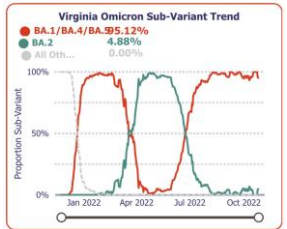
- **Variants have been observed to:** increase transmissibility, increase severity (more hospitalizations and/or deaths), and limit immunity provided by prior infection and vaccinations



Omicron Updates

- Soup of tracked variants has grown to 53% from 41% last week
- BQ.1.1 continues to show quick growth up to 17% from 11%, with BQ.1.* accounting for another 10%
- BF.7 continues steady slow growth at 8.4%
- BA.4.6 remains steady at 11-13% for last 5 weeks
- BQ.1.1 recently seeing growth in England and other countries that mimics past variants of concern that have gone on to dominate
- XBB and subvariants remain a concern





Walgreens
SGTF (BA.2*) at ~5%

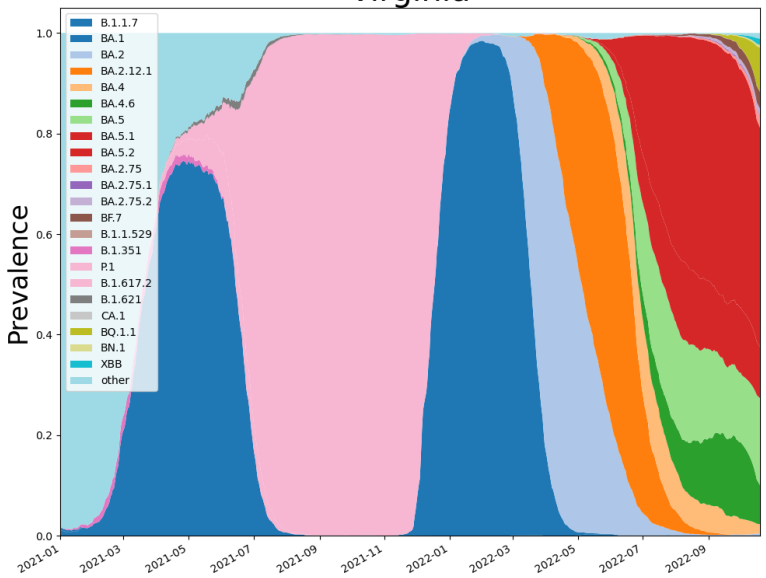
CDC Variant Tracking

SARS-CoV2 Omicron Sub-Variants

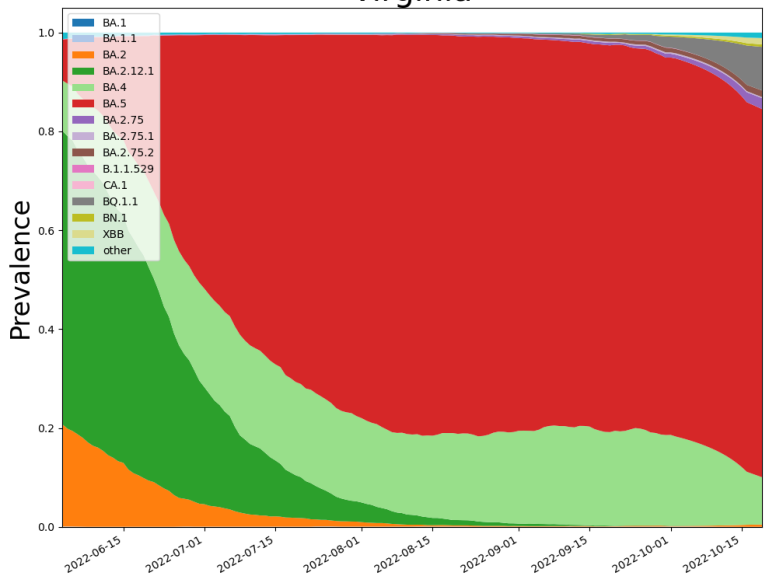
covSPECTRUM
Enabled by data from GISAID

As detected in whole Genomes in public repositories

Virginia

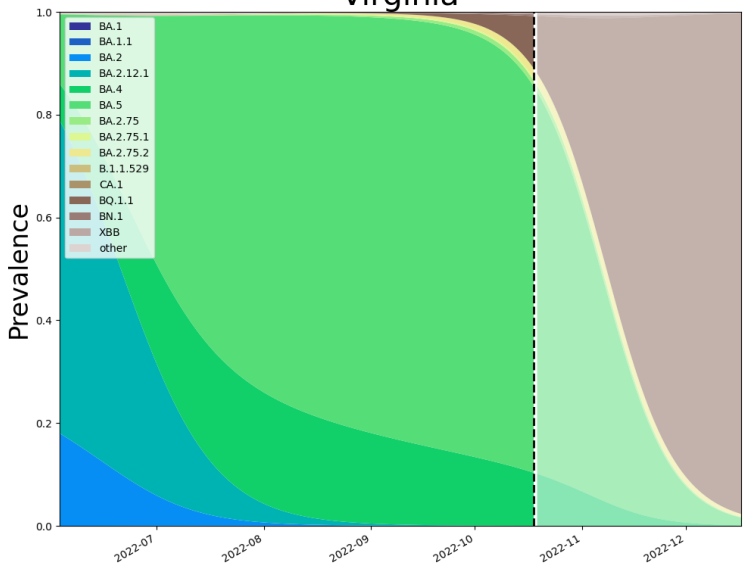


Virginia

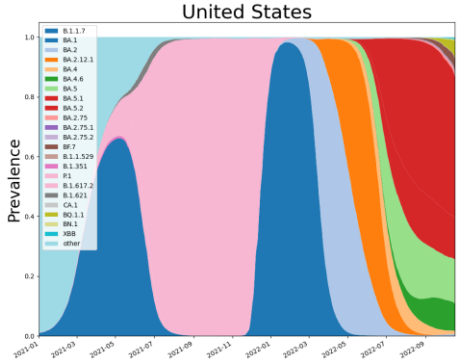


VoC Polynomial Fit Projections

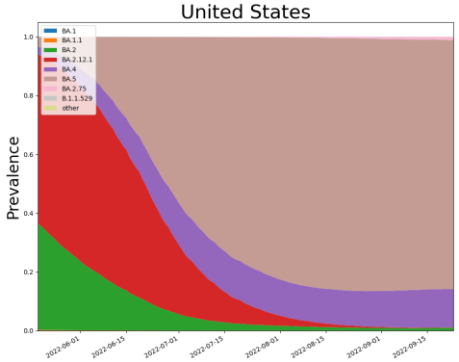
Virginia



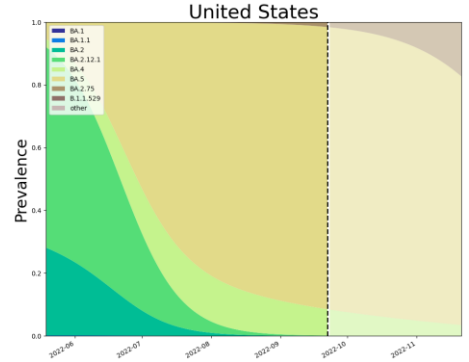
United States



United States



United States



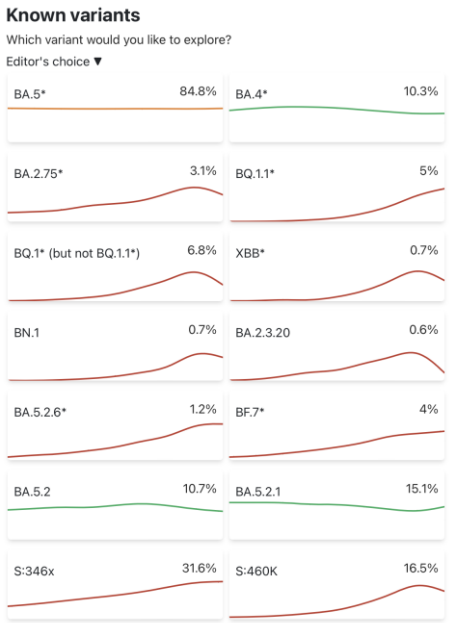
Note: Data lags force projections to start in past. Everything from dotted line forward is a projection.

SARS-CoV2 Omicron Sub-Variants

[COV-spectrum](#)

"Editor's choice"

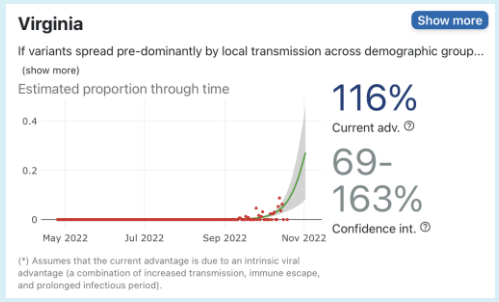
Variants to watch

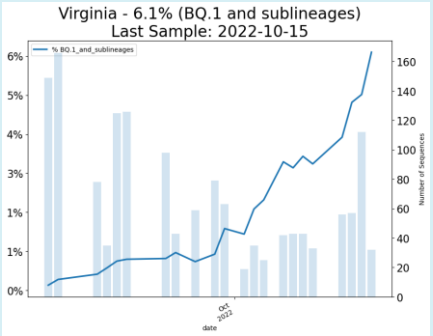


covSPECTRUM

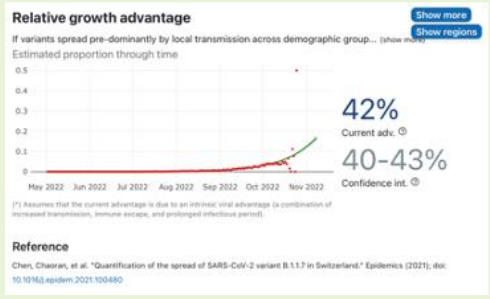
Enabled by data from GISAID

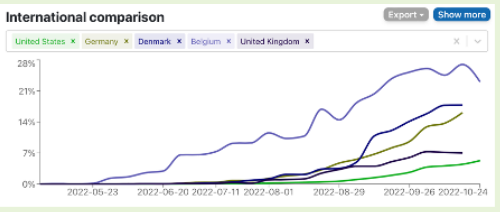
BQ.1.1

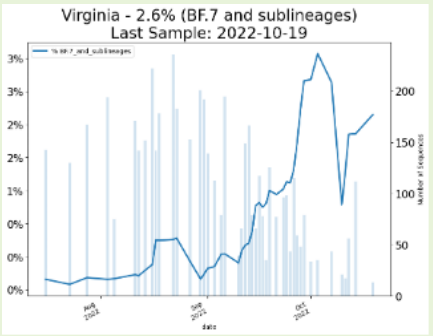




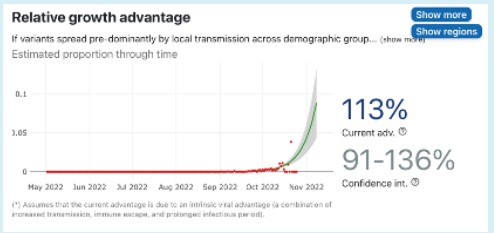
BF.7

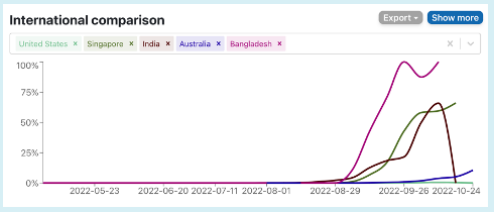


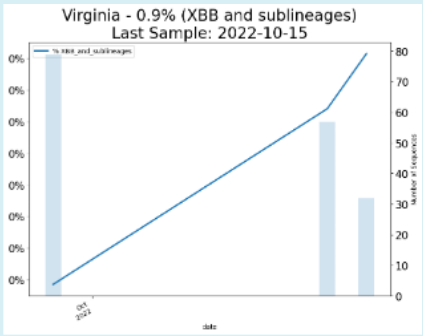




XBB*







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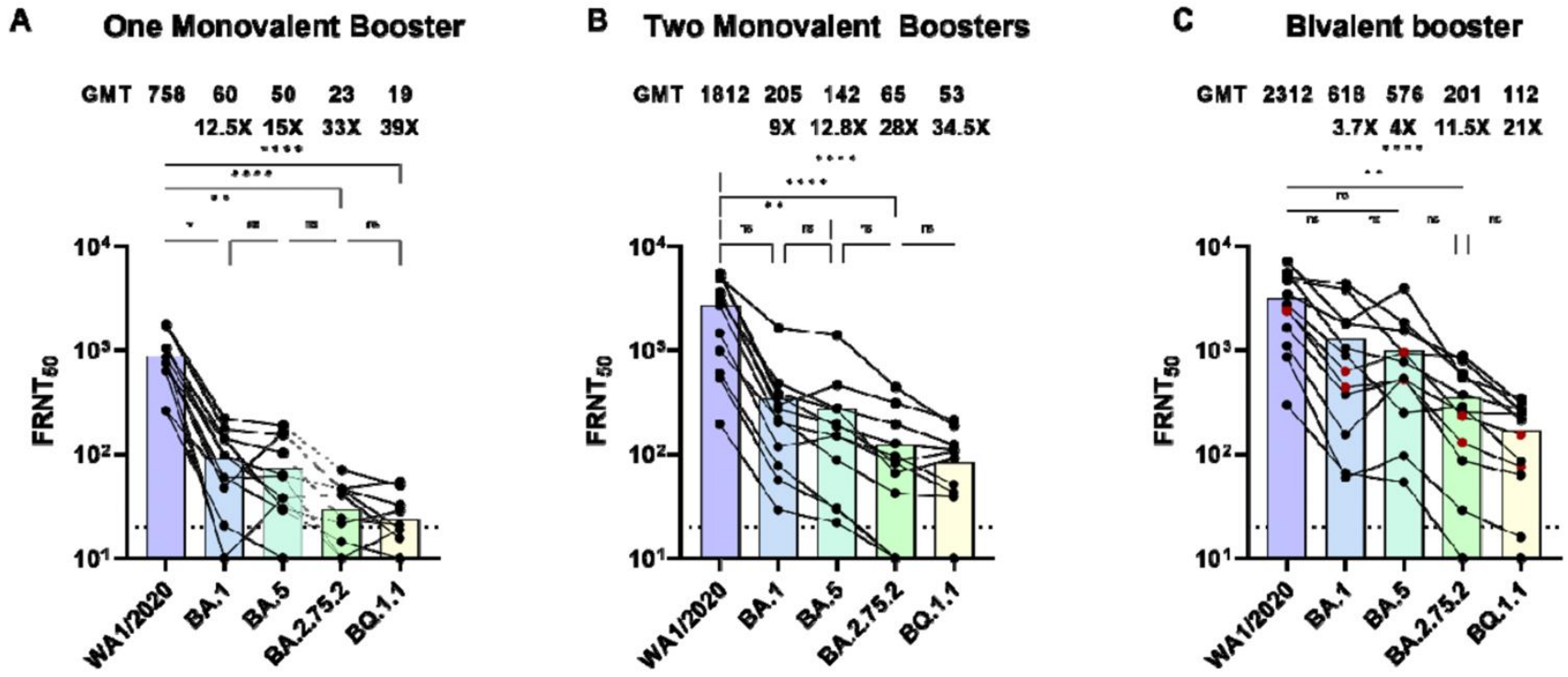
Pandemic Pubs (Nov 2nd, 2022)

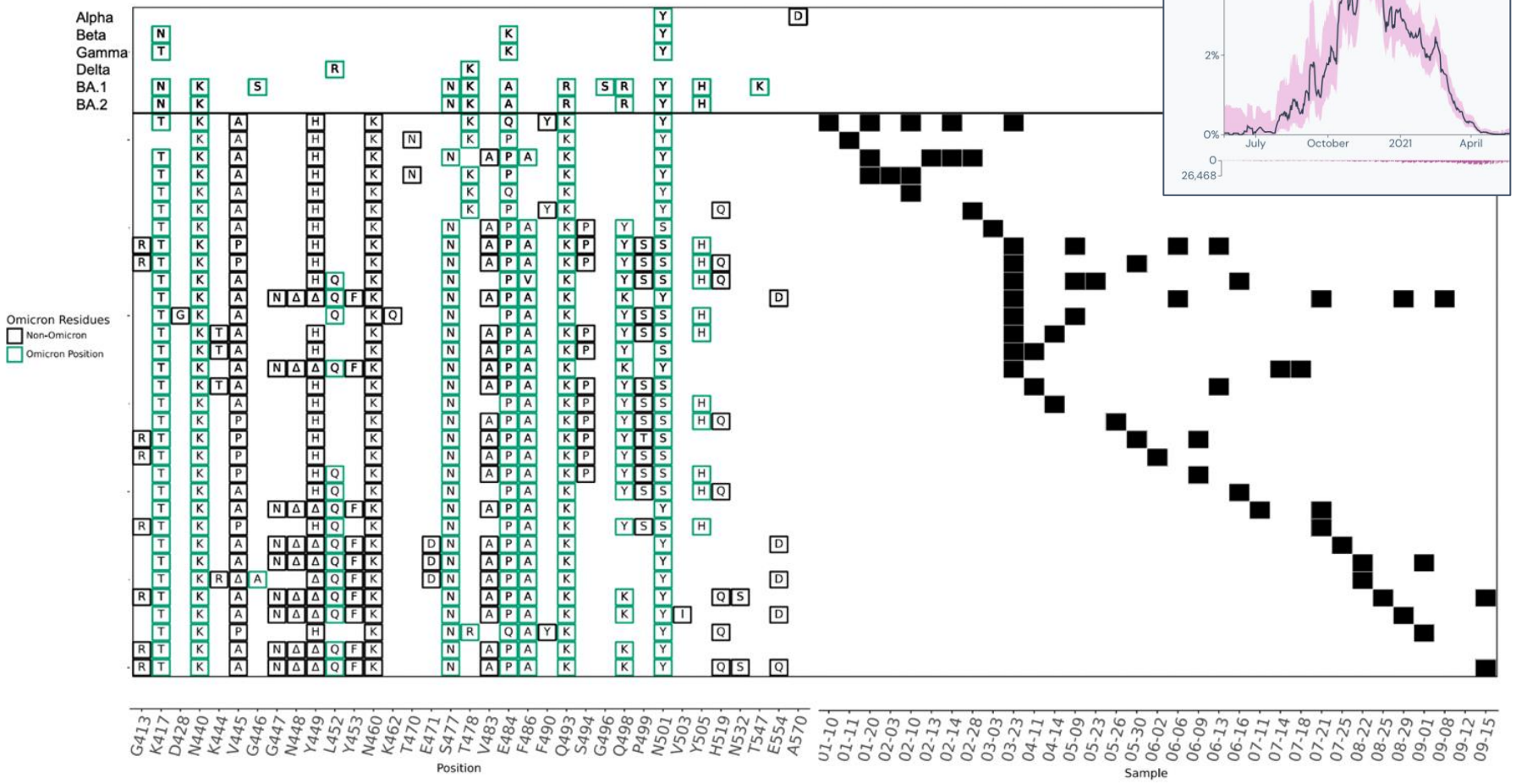
1. Data suggest that the bivalent mRNA booster vaccine broadens humoral immunity against the Omicron subvariants.



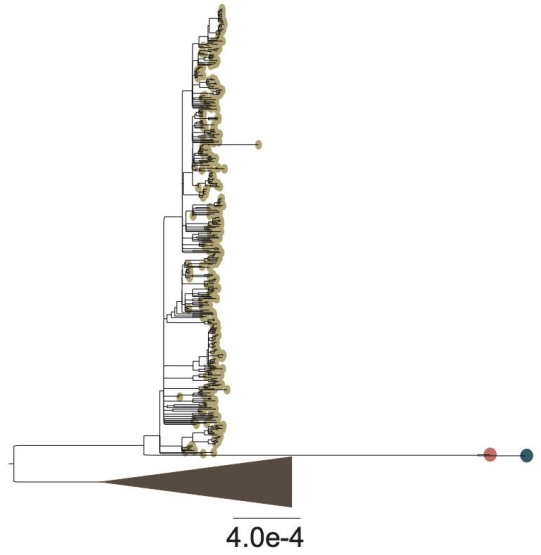
Researchers at Emory, Stanford, and NIAID evaluated serum samples from individuals who had received either one or two monovalent boosters or the bivalent booster to determine neutralizing activity against wild-type and Omicron subvariants BA.1, BA.5, BA.2.75.2, and BQ.1.1. Monovalent booster cohort: relative to WA1/2020, observed a reduction in neutralization titers of 9-15-fold against BA.1 and BA.5 and 28-39-fold against BA.2.75.2 and BQ.1.1. In the BA.5-containing bivalent booster cohort, the neutralizing activity improved against all the Omicron subvariants. Relative to wildtype observed a reduction in neutralization titers of 3.7- and 4-fold against BA.1 and BA.5, respectively, and 11.5- and 21-fold against BA.2.75.2 and BQ.1.1, respectively. These data suggest that the bivalent mRNA booster vaccine broadens humoral immunity against the Omicron subvariants.
https://www.biorxiv.org/content/10.1101/2022.10.31.514636v1

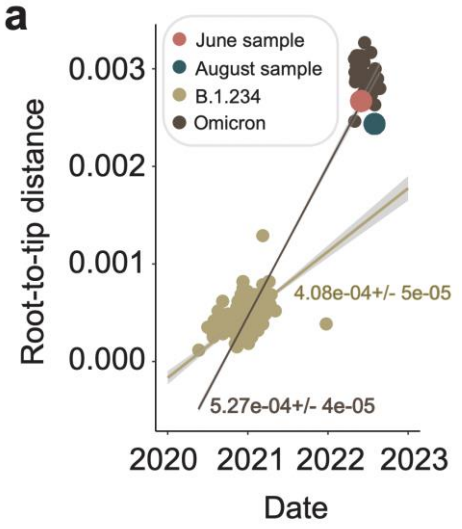
Pandemic Pubs (Nov 2nd, 2022)

2. Omicron-like Spike mutations, likely chronic infection, detected in wastewater



The authors suggest "**The simplest explanation of this data is that a single individual, originally infected when B.1.234 was in circulation, excreted viruses with the cryptic lineage in 2022.**"



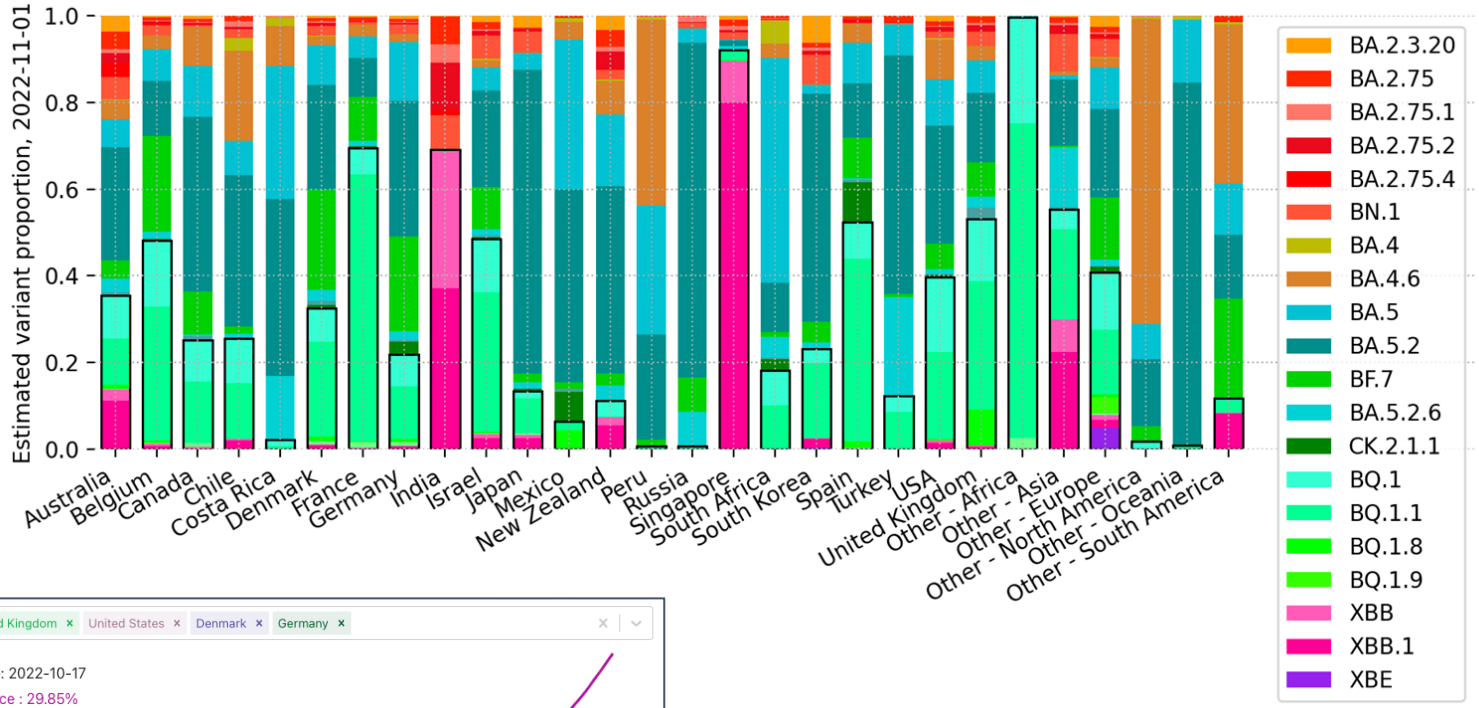


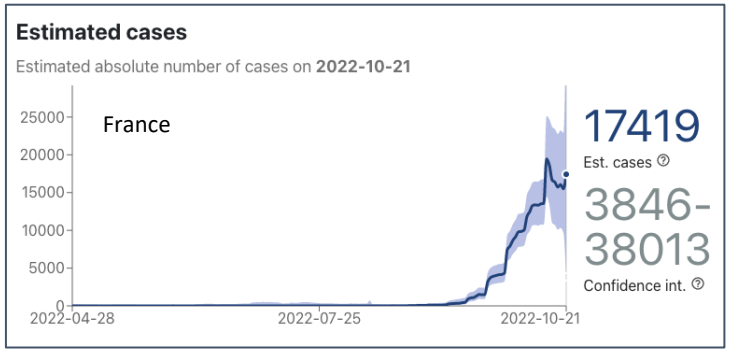
Researchers used wastewater to track unique lineage to its source. Mutations found in surveillance over time indicate a likely chronic intestinal infection. Mutational patterns are similar to that observed with Omicron and in immunocompromised individuals. On January 11, 2022, a cryptic lineage containing at least six unusual Spike RBD variants was first detected in a composite wastewater sample from a metropolitan area in Wisconsin. Wastewater samples for this study (January 2022 through September 2022) were collected in collaboration with experienced wastewater engineers from the city wastewater utility tracing it back to building of origin (human source). Haplotypes are displayed on each row which represented at least 25% of the total sequences in at least one sample. Green boxes indicate residues that are also altered in Omicron (BA.1 or BA.2). Δ indicates an in-frame amino acid deletion. Notably, mutations have accumulated in this lineage faster than expected based on the substitution rate that prevailed when B.1.234 viruses were circulating. A substantially elevated rate of nonsynonymous substitutions was detected in the spike gene, but not in other viral genes. These observations suggest that Spike variation in this virus is driven by diversifying selection
https://www.medrxiv.org/content/10.1101/2022.10.28.22281553v1

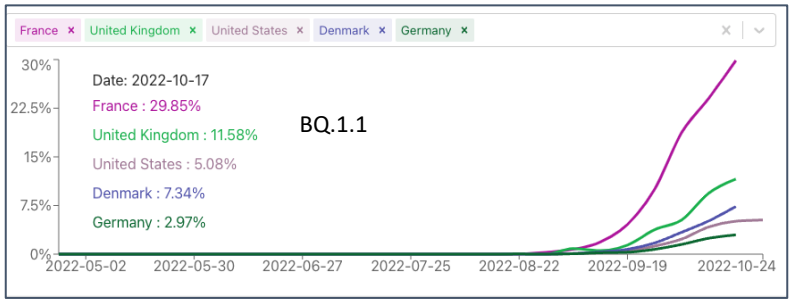
Pandemic Pubs (Nov 2nd, 2022)

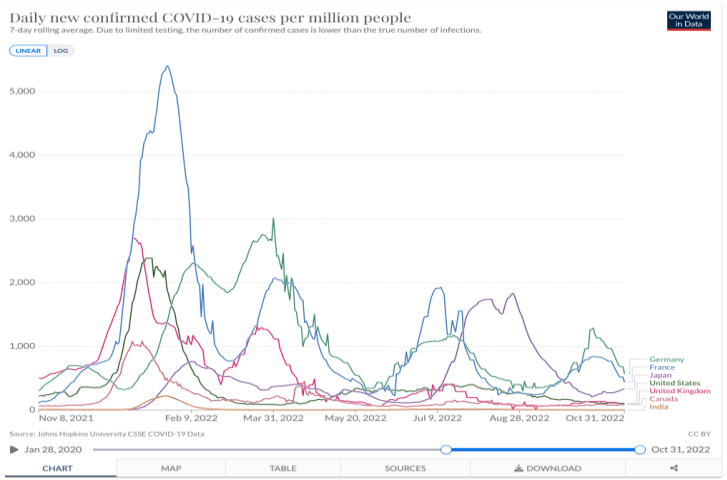
- Professor Moritz Gerstung provides analysis based on sequence surveillance around the world finding a likely BQ.1.1 growth advantage over XBB.1
- France will be an important country to watch in the coming weeks due to current BQ.1.1 dominance

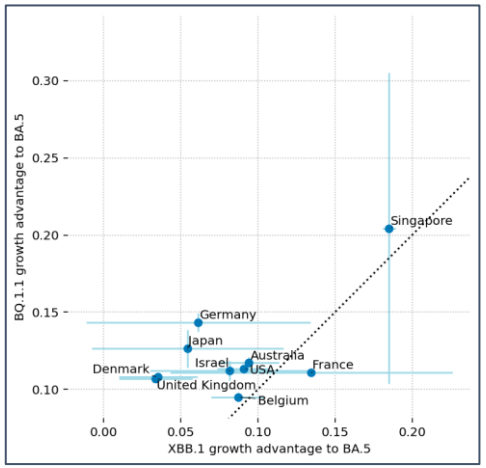
https://twitter.com/MoritzGerstung/status/1585667948311678978
https://cov-spectrum.org/explore/France/AllSamples/Past6M/variants?nextcladePangoLineage=bq.1.1*&
https://ourworldindata.org/covid-cases

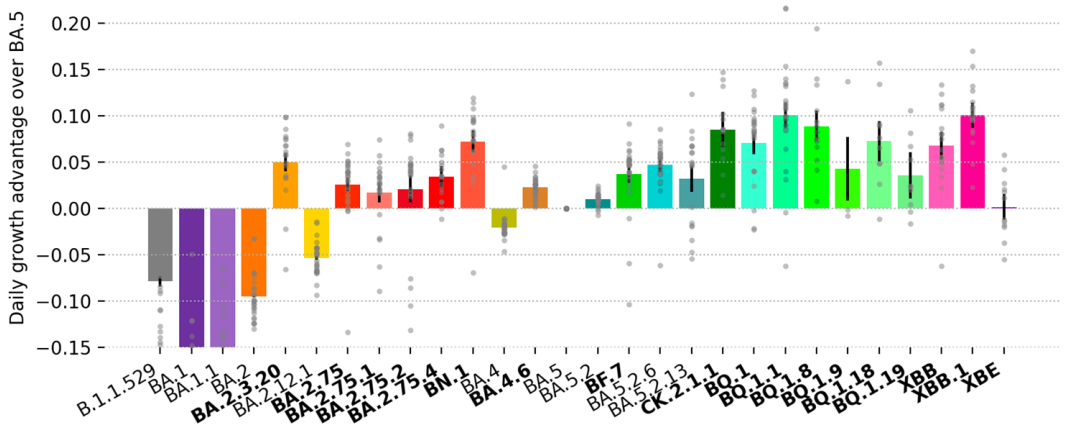






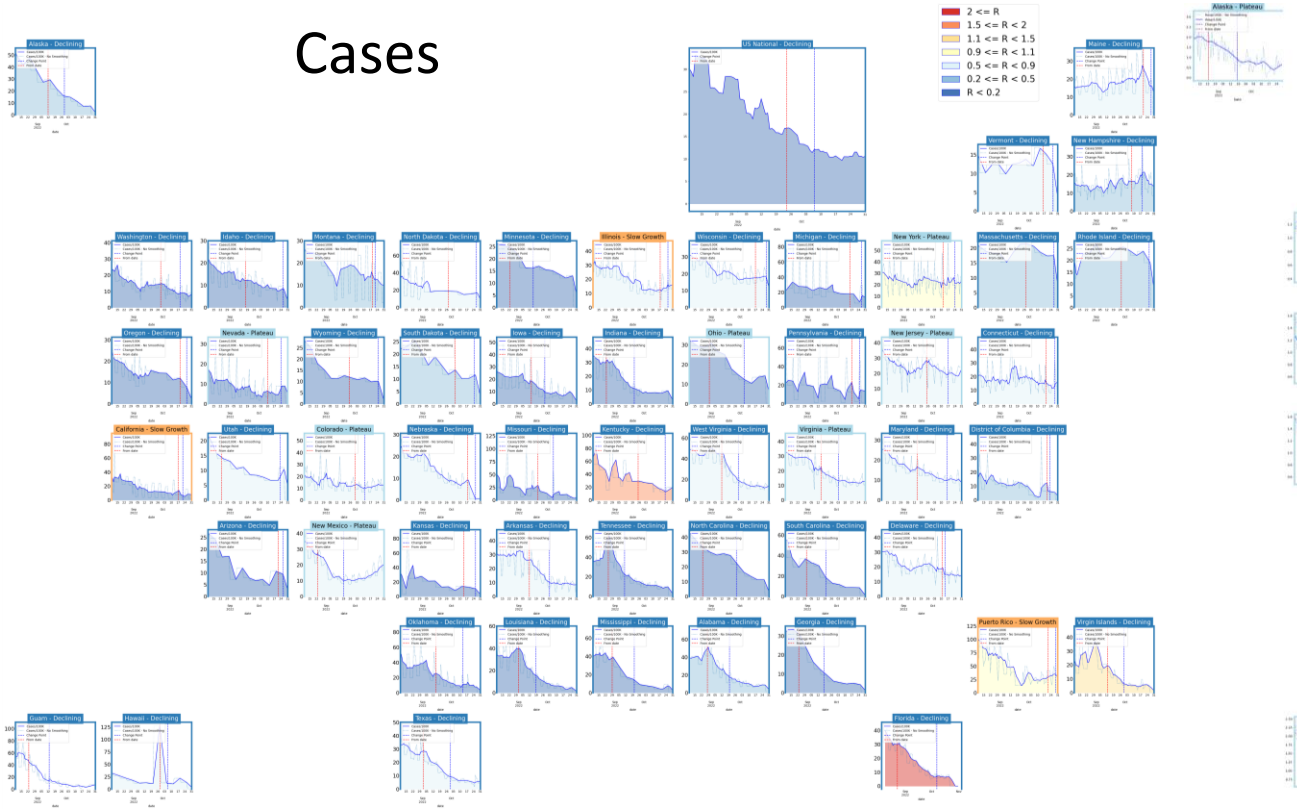




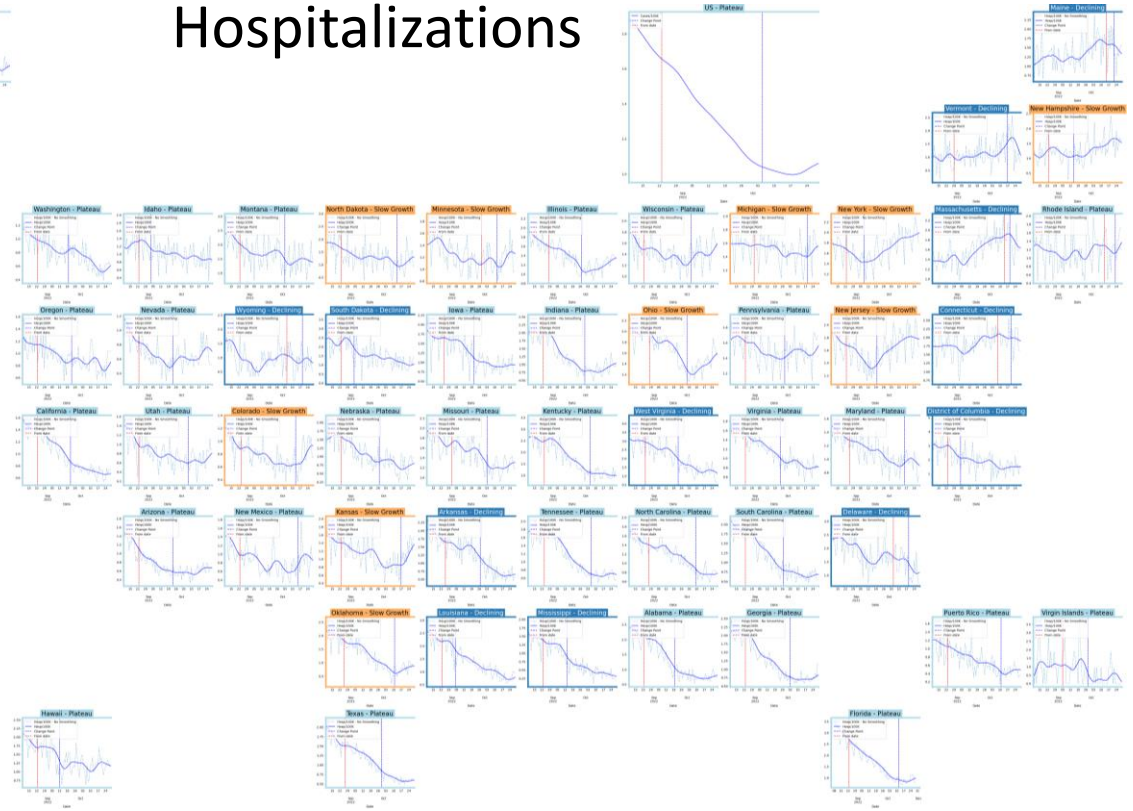


United States Case & Hospitalizations

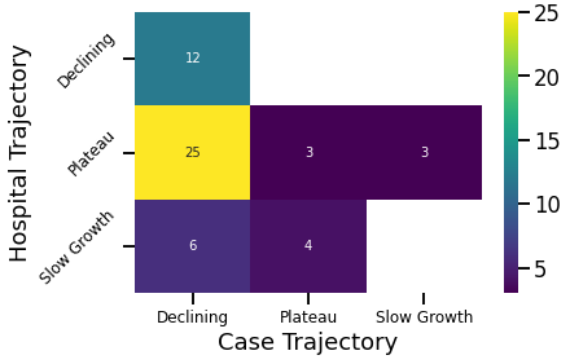
Cases



Hospitalizations



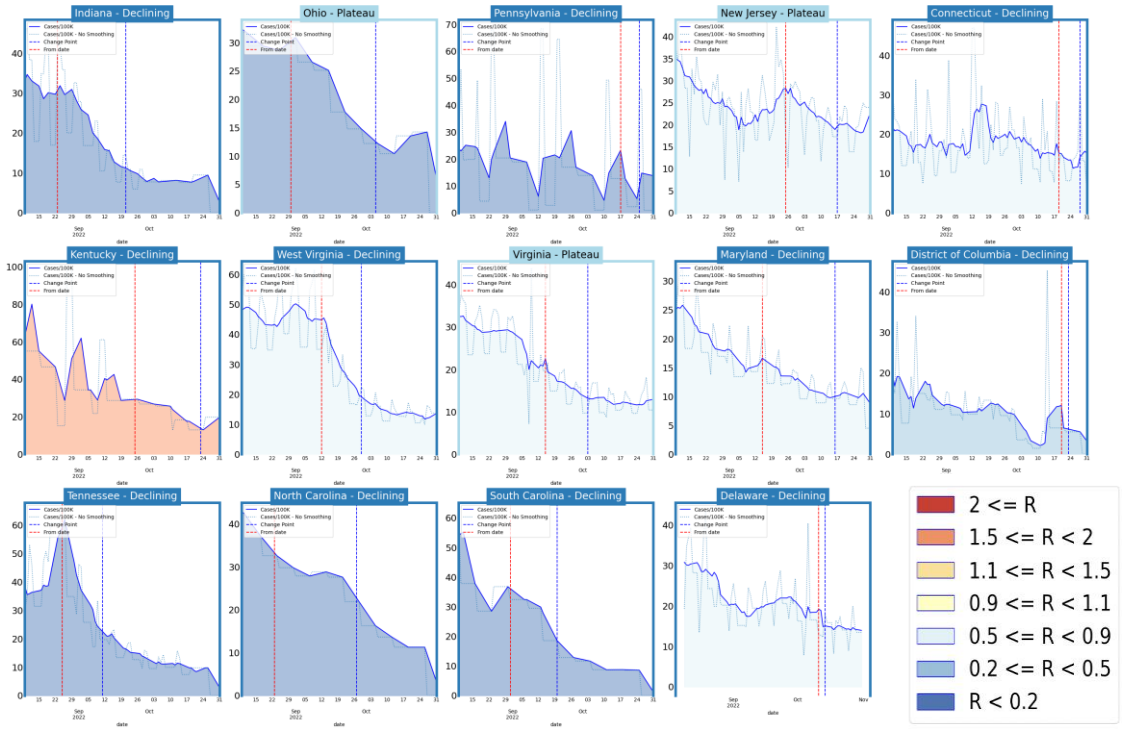
Status	Number of States	
	Current Week	Last Week
Declining	44	(46)
Plateau	7	(6)
Slow Growth	3	(2)
In Surge	0	(0)



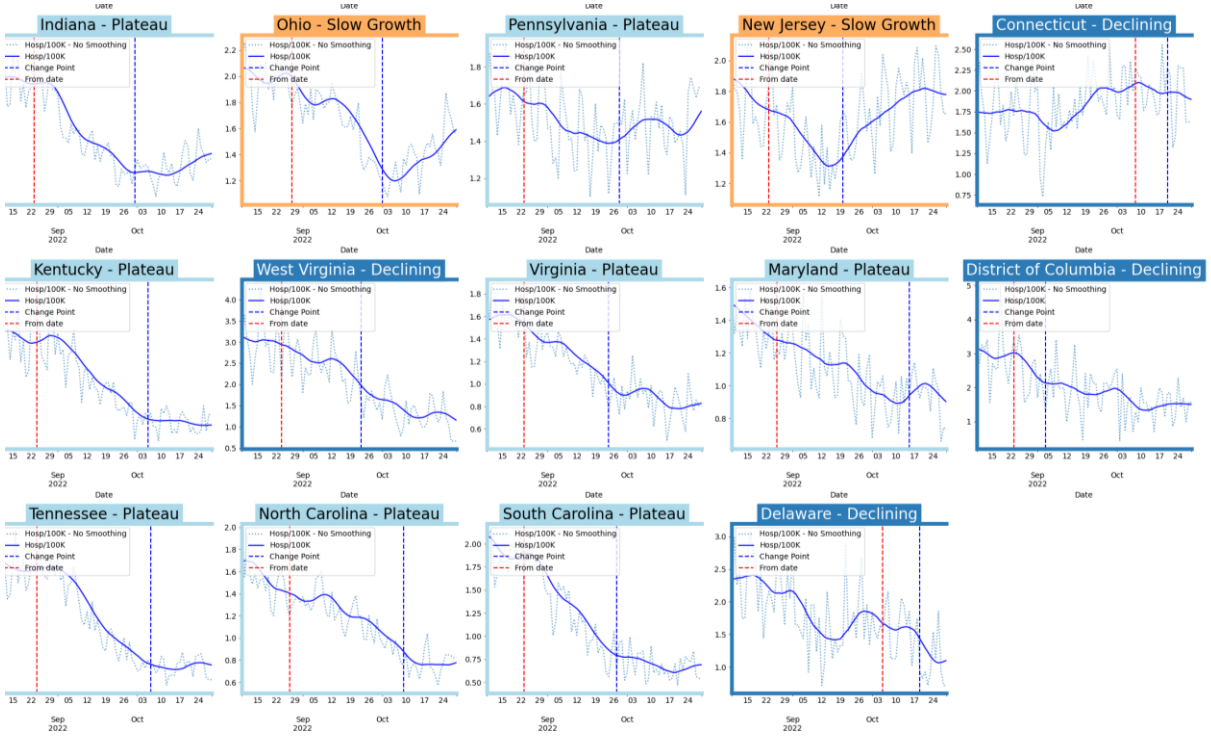
Status	Number of States	
	Current Week	Last Week
Declining	12	(16)
Plateau	31	(28)
Slow Growth	10	(8)
In Surge	0	(1)

Virginia and Her Neighbors

Cases

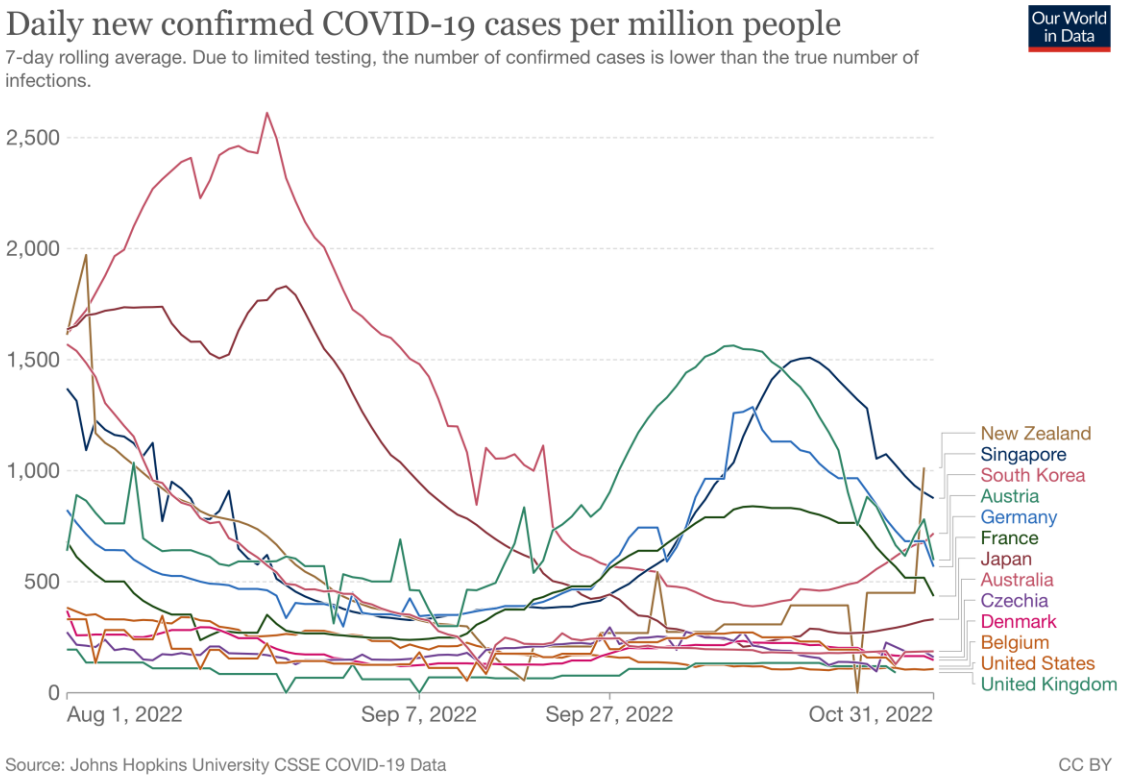


Hospitalizations

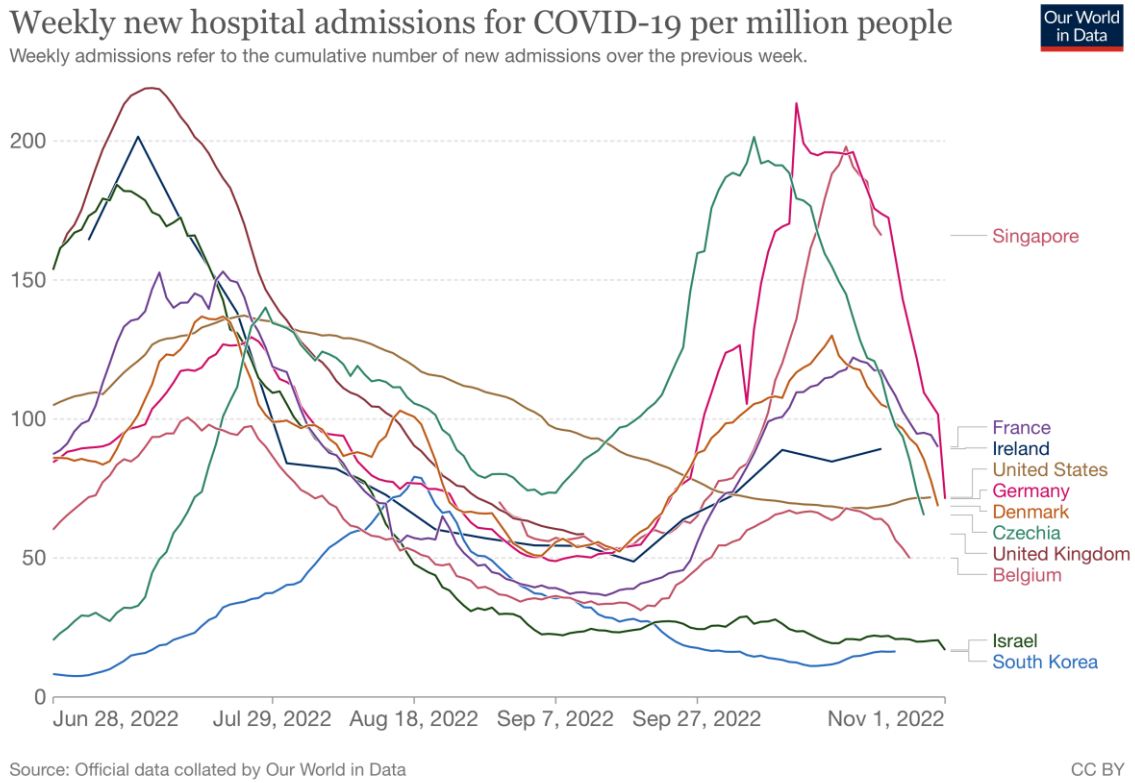


Around the World – Various trajectories

Confirmed cases



Hospitalizations



Our World in Data [Our World in Data]

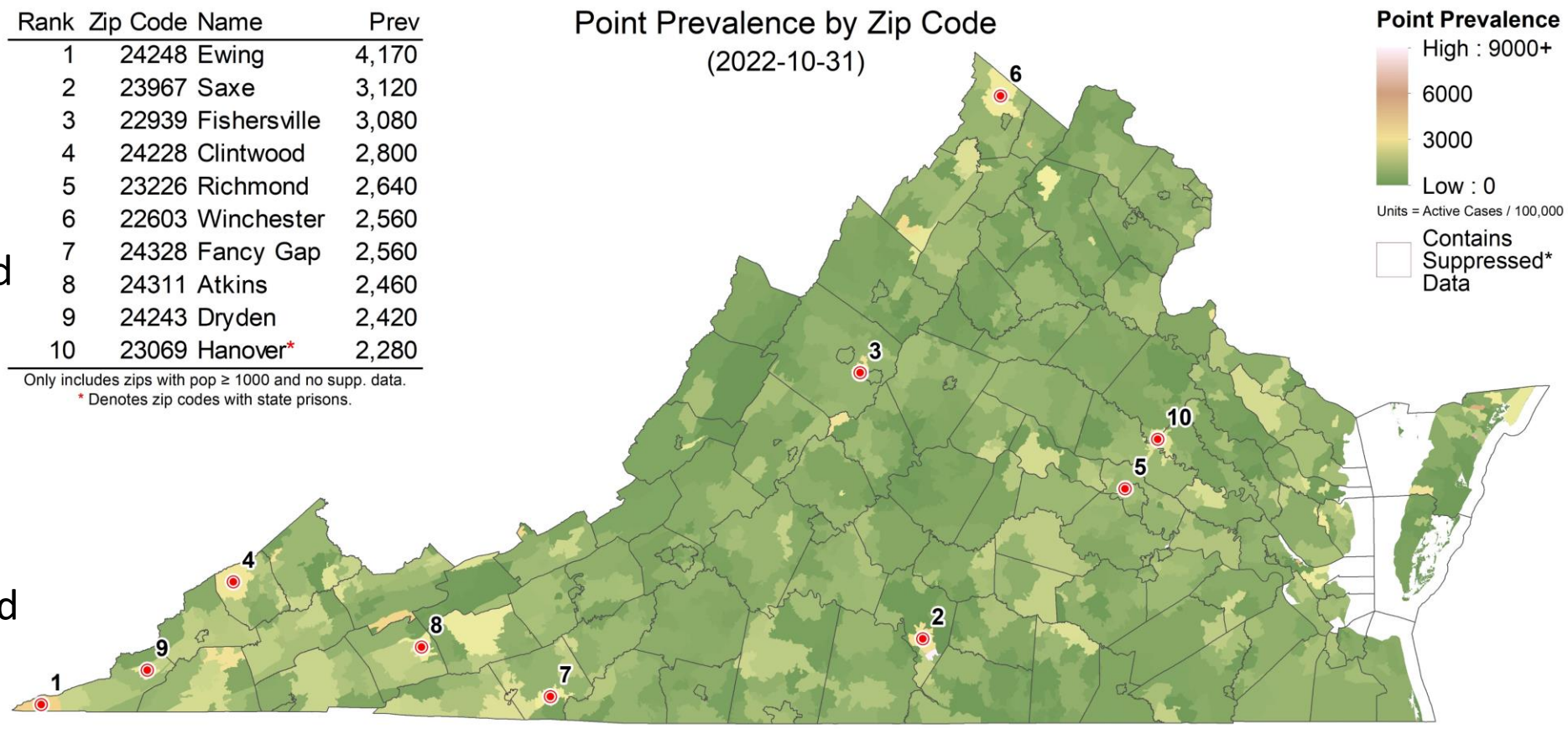
Zip code level weekly Case Rate (per 100K)

Case Rates in the last week by zip code

- Statewide rates are still quite low. No zip code exceeds 5,000 per 100k point prevalence.
- High prevalence areas are randomly distributed around Virginia. Only one holds a prison.
- Lee County is the only one with multiple zip codes in the top 10.
- Some counts are low and suppressed to protect anonymity. Those are shown with a dark red outline.

Rank	Zip Code	Name	Prev
1	24248	Ewing	4,170
2	23967	Saxe	3,120
3	22939	Fishersville	3,080
4	24228	Clintwood	2,800
5	23226	Richmond	2,640
6	22603	Winchester	2,560
7	24328	Fancy Gap	2,560
8	24311	Atkins	2,460
9	24243	Dryden	2,420
10	23069	Hanover*	2,280

Only includes zips with pop ≥ 1000 and no supp. data.
* Denotes zip codes with state prisons.



Based on Spatial Empirical Bayes smoothed point prevalence, with an 8:1 ascertainment ratio, for week ending 2022-10-31.

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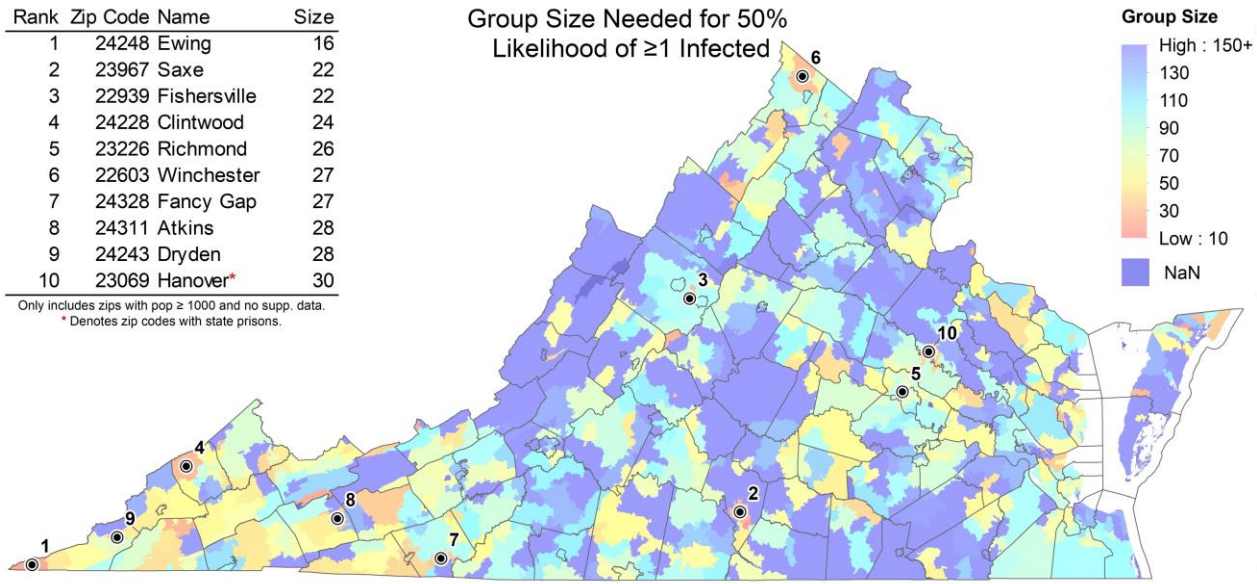
Risk of Exposure by Group Size and HCW prevalence

Case Prevalence in the last week by zip code used to calculate risk of encountering someone infected in a gathering of randomly selected people

- **Group Size**: Assumes **8 undetected infections** per confirmed case (ascertainment rate from recent seroprevalence survey) and shows minimum size of a group with a 50% chance an individual is infected by zip code (e.g., in a group of 16 in Ewing, there is a 50% chance someone will be infected).
- **HCW ratio**: Case rate among health care workers (HCW) in the last week using patient facing health care workers as the denominator / population's case prevalence. Madison Co. is #1 in prevalence and #2 by ratio.

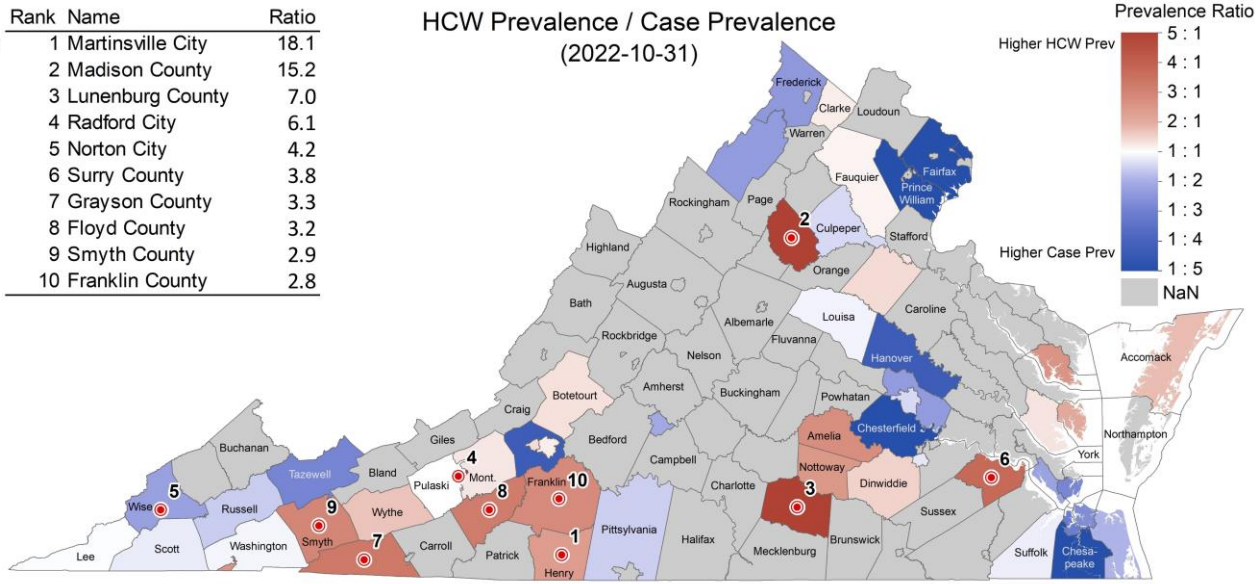
Rank	Zip Code	Name	Size
1	24248	Ewing	16
2	23967	Saxe	22
3	22939	Fishersville	22
4	24228	Clintwood	24
5	23226	Richmond	26
6	22603	Winchester	27
7	24328	Fancy Gap	27
8	24311	Atkins	28
9	24243	Dryden	28
10	23069	Hanover*	30

Only includes zips with pop ≥ 1000 and no supp. data.
* Denotes zip codes with state prisons.



Based on Spatial Empirical Bayes smoothed point prevalence, with an 8:1 ascertainment ratio, for week ending 2022-10-31.

Rank	Name	Ratio
1	Martinsville City	18.1
2	Madison County	15.2
3	Lunenburg County	7.0
4	Radford City	6.1
5	Norton City	4.2
6	Surry County	3.8
7	Grayson County	3.3
8	Floyd County	3.2
9	Smyth County	2.9
10	Franklin County	2.8



Note: This assumes that the ascertainment rate of healthcare workers is double that of the public.

Current Hot-Spots

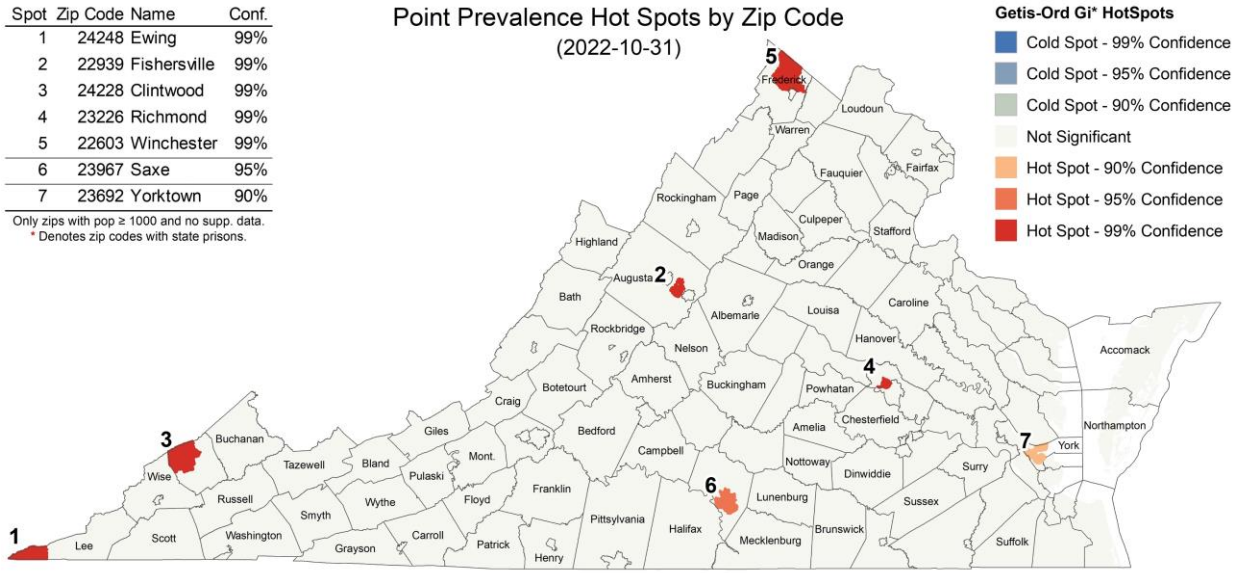
Case rates that are significantly different from neighboring areas or model projections

- **Spatial**: Getis-Ord Gi* based hot spots compare clusters of zip codes with weekly case prevalence higher than nearby zip codes to identify larger areas with statistically significant deviations
- **Temporal**: The weekly case rate (per 100K) projected last week compared to observed by county, which highlights temporal fluctuations that differ from the model's projections.
- Spatial hotspots are sporadic. Temporal hotspots are west of Lynchburg. At the county-level there is significant variation. At the district level, these values average out to mild underpredictions.

Spatial Hotspots

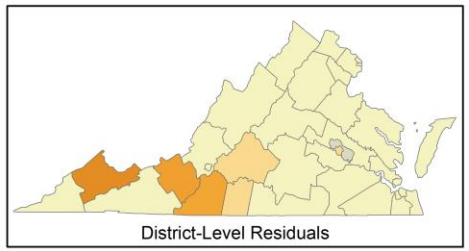
Spot	Zip Code	Name	Conf.
1	24248	Ewing	99%
2	22939	Fishersville	99%
3	24228	Clintwood	99%
4	23226	Richmond	99%
5	22603	Winchester	99%
6	23967	Saxe	95%
7	23692	Yorktown	90%

Only zips with pop ≥ 1000 and no supp. data.
* Denotes zip codes with state prisons.



Based on Global Empirical Bayes smoothed point prevalence for week ending 2022-10-31.

Clustered Temporal Hotspots

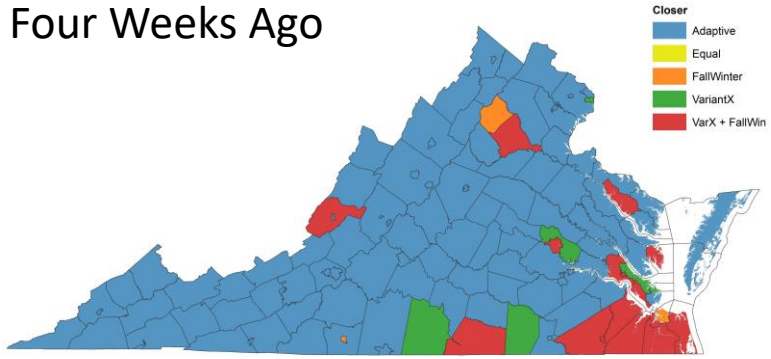


Health District Level Moran's I = -0.053915, Z-Score = -0.428305, P-Value = 0.668429
No Residual Autocorrelation Detected

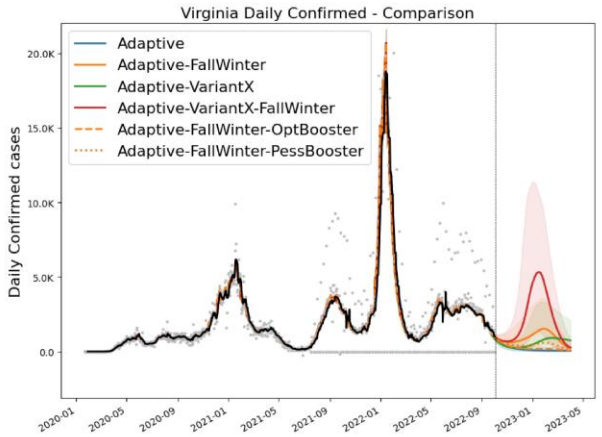
Scenario Trajectory Tracking

Which scenario from a month ago did projection for each county track closest?

Four Weeks Ago



Two Weeks Ago



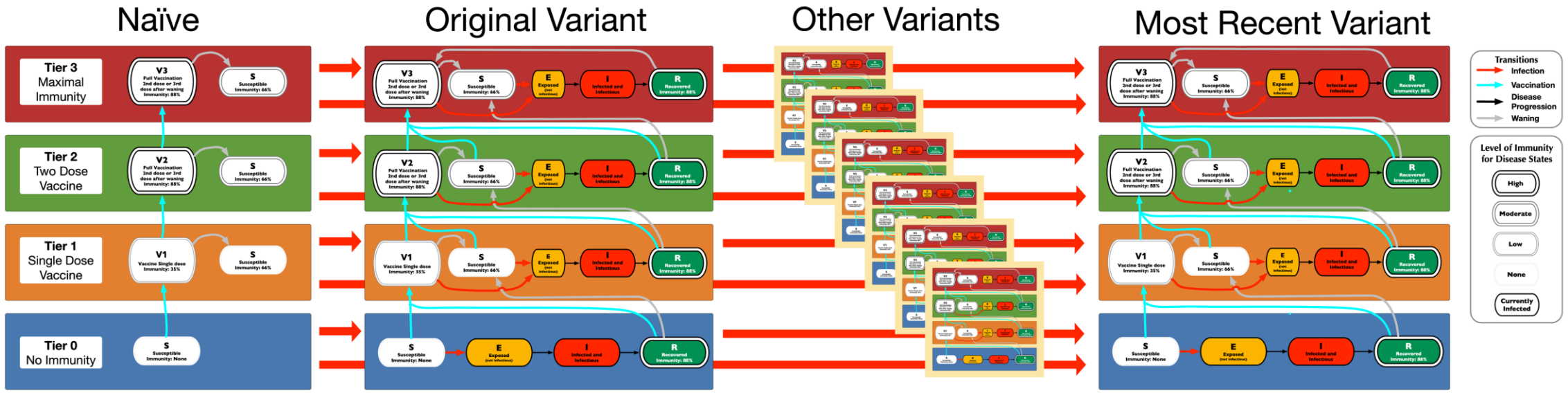
- One month out separates the projections more and reveals larger overall patterns.
- A month ago, case rates were best tracked by the Adaptive scenario. Today case rates best tracked by the VariantX-FallWinter scenario. This suggests that the underlying mechanics of the epidemic have changed.

Model Update – Adaptive Fitting

Model Structure Extended for more sub-variants

Omicron sub-variants escape immunity induced by previous sub-variants

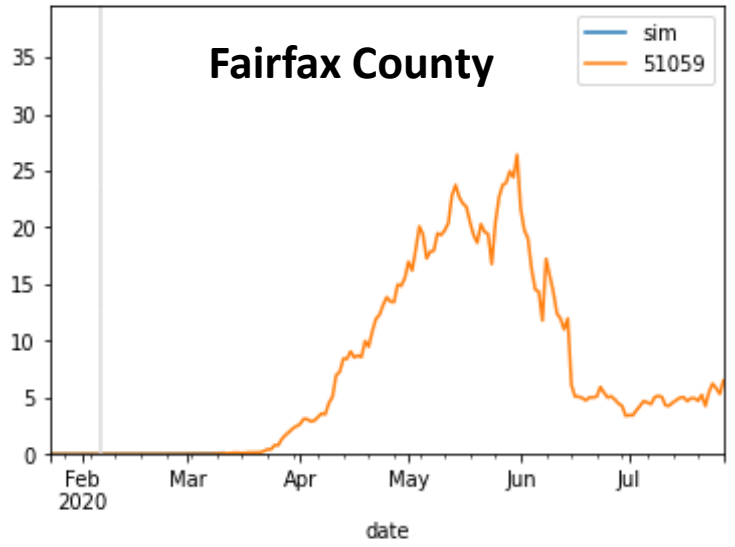
- Multiple strain support allows representation of differential protection based on immunological history (BA.1, BA.2, BA.2.12.1, BA.4/5, and future variants (VariantX))
- Each sub-variant has differing levels of immune escape to previous sub-variants, the prevalences are based on observations for fitting purposes, and projections use estimated future prevalences
- Adaptive fitting approach continues to use simulation to generate the full distribution of immune states across the population



Adaptive Fitting Approach

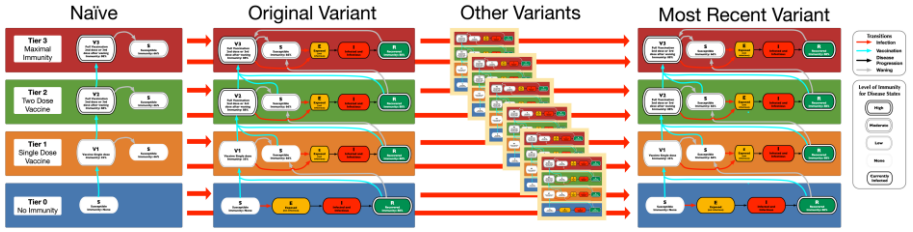
Each county fit precisely, with recent trends used for future projection

- Allows history to be precisely captured, and used to guide bounds on projections



Model: An alternative use of the same meta-population model, PatchSim with multiple tiers of immunity

- Allows for future "what-if" Scenarios to be layered on top of calibrated model
- Allows for waning of immunity and for partial immunity against different outcomes (eg lower protection for infection than death)



External Seeding: Steady low-level importation

- Widespread pandemic eliminates sensitivity to initial conditions, we use steady 1 case per 10M population per day external seeding

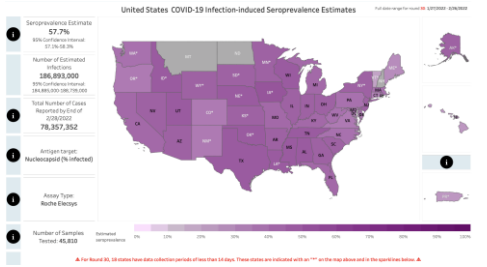
Seroprevalence updates to model design

Several seroprevalence studies have stopped

- CDC Nationwide Commercial Laboratory Seroprevalence Survey is no longer reporting updates; pre-Omicron this data estimated ascertainment ratio of ~4-6x

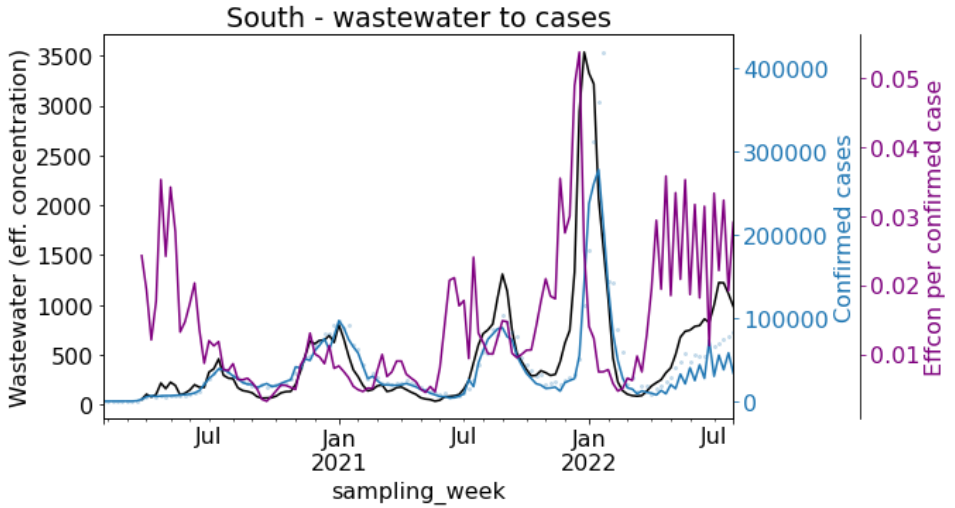
Testing Behavior has changed, fewer cases are reported

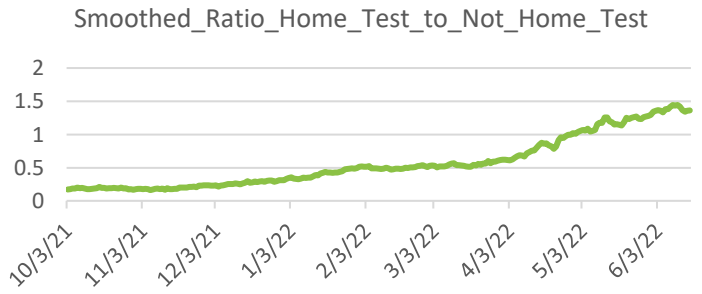
- Home testing, reduced symptoms due to breakthrough / reinfection, and elimination of public health leave
- Outbreaks Near Me from Boston Children's Hospital and Momentive collects reports of home testing
- Wastewater data is consistent with case ascertainment being significantly lower than during the Omicron BA.1 wave
- Accounting for home testing, changes case ascertainment to be 2 times more than pre-Omicron resulting in a current rate of 16 infections to one case



Virginia
Feb 22nd: 45% [42% - 48%];
Jan 22nd: 34% [31%-39%]

https://covid.cdc.gov/covid-data-tracker/#national-lab





OutbreaksNearMe

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Calibration Approach

- **Data:**
  - County level case counts by date of onset (from VDH)
  - Confirmed cases for model fitting
- **Calibration:** fit model to observed data and ensemble's forecast
  - Tune transmissibility across ranges of:
    - Duration of incubation (5-9 days), infectiousness (3-7 days)
    - Undocumented case rate (1x to 7x) guided by seroprevalence studies
    - Detection delay: exposure to confirmation (4-12 days)
  - Approach captures uncertainty, but allows model to precisely track the full trajectory of the outbreak
- **Project:** future cases and outcomes generated using the collection of fit models run into the future
  - **Mean trend from last 7 days of observed cases and first week of ensemble's forecast used**
  - Outliers removed based on variances in the previous 3 weeks
  - 2 week interpolation to smooth transitions in rapidly changing trajectories
- **Outcomes**: Data driven by shift and ratio that has least error in last month of observations
  - Hospitalizations: 3 days from confirmation, 6.8% of cases hospitalized
  - Deaths: 11 days from confirmation, 1.45% of cases die

VIRGINIA'S HEALTH IS IN OUR HANDS. Do your part, stop the spread.

COVID-19 in Virginia: Summary

VDH VIRGINIA DEPARTMENT OF HEALTH

Dashboard Updated: 11/2/2022
Data entered by 5:00 PM the prior day.

Cases, Hospitalizations and Deaths

Total Cases*	Total Hospital Admissions**	Total Deaths
2,122,439	57,020	22,211
(New Cases: 1,094)^		

Confirmed†	Probable†	Confirmed†	Probable†	Confirmed†	Probable†
1,500,126	622,313	53,489	3,531	18,438	3,773

* Includes both people with a positive test (Confirmed), and symptomatic with a known exposure to COVID-19 (Probable).
** Hospitalization of a case is captured at the time VDH performs case investigation. This underrepresents the total number of hospitalizations in Virginia.
^New cases represent the number of confirmed and probable cases reported to VDH in the past 24 hours.
† VDH adopted the updated CDC COVID-19 confirmed and probable surveillance case definitions on September 1st, 2021. Found here: https://ndc.services.cdc.gov/case-definitions/coronavirus-disease-2019-2021/
Source: Cases - Virginia Electronic Disease Surveillance System (VEDSS), data entered by 5:00 PM the prior day.

Outbreaks

Total Outbreaks*	Outbreak Associated Cases
10,108	165,813

* At least two (2) lab confirmed cases are required to classify an outbreak.

Testing (PCR Only)

Testing Encounters PCR Only*	Current 7-Day Positivity Rate PCR Only**
15,256,622	8.9%

* PCR" refers to "Reverse transcriptase polymerase chain reaction laboratory testing."
** Lab reports may not have been received yet. Percent positivity is not calculated for days with incomplete data.

Multisystem Inflammatory Syndrome in Children

Total Cases*	Total Deaths
181	1

*Cases defined by CDC HAN case definition: https://emergency.cdc.gov/han/2020/han00432.asp

Accessed 9:00am November 2, 2022
https://www.vdh.virginia.gov/coronavirus/

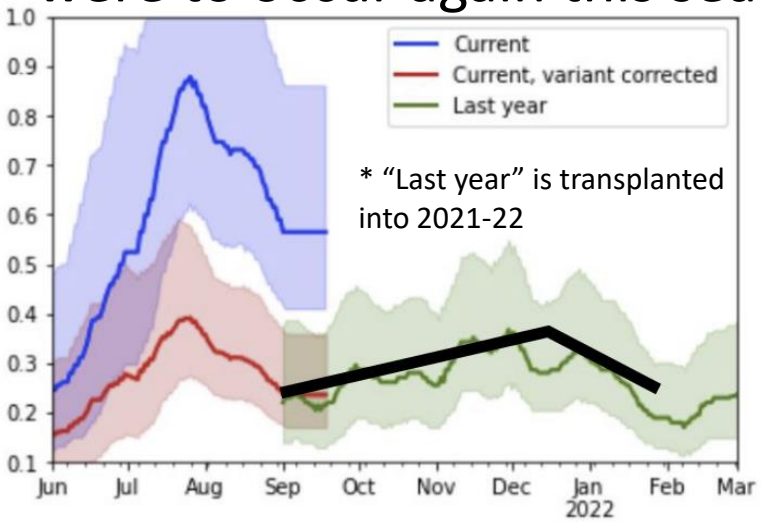
Scenarios – Transmission Conditions

- Variety of factors continue to drive transmission rates
  - Seasonal impact of weather patterns, travel and gatherings, fatigue and premature relaxation of infection control practices
- **Waning Immunity**: Omicron waning with a mean of 4 months
- **Projection Condition Ingredients**:
  - **Adaptive:** Controls remain as currently experienced into the future with NO influence from other conditions (eg seasonal, variants, etc.)
  - **Seasonal (Fall-Winter boosting):** Controls remain the same, however, seasonal forcing similar to past Fall-Winter waves is added from Sept-Feb
  - **Vaccine Booster Campaign (Booster):** Reformulated booster available this fall provides improved immunity against Omicron sub-variants
  - **New Variants (VariantX)**: As of yet unidentified novel sub-variant with similar immune escape but no transmission advantage emerges 4 months after the last significant sub-variant and grows at a similar rate

Scenarios – FallWinter

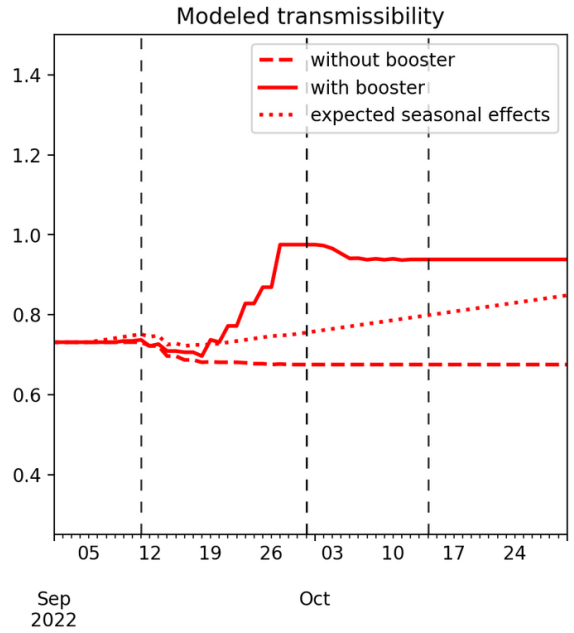
September – February saw strong waves of transmission for both years

- Based on analyses of the past 2 seasons we generate a “coarse baseline transmission boost”
  - In 2021 the distribution of fitted model transmissibility was nearly identical between these periods when corrected for Delta’s increased transmissibility
- **FallWinter** captures these “transmission drivers” from the past and uses them as if they were to occur again this season



Fitting: Black line represents the coarsely fitted base transmissibility

2022 FallWinter is likely different:
With the current level of boosting the transmissibility needs to be much higher to maintain the same amount of cases. The dotted line shows what transmission levels are needed to fit cases without booster and with seasonal effects.



Scenarios – Optimistic vs. Pessimistic Booster Coverage

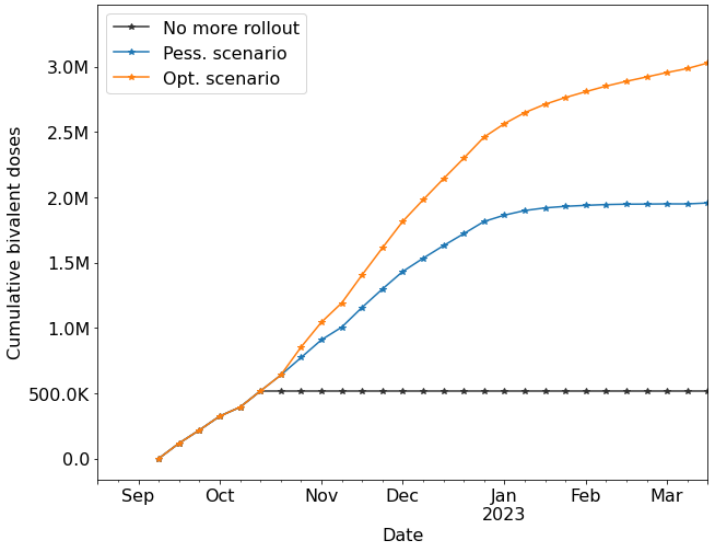
Reformulated Boosters available now

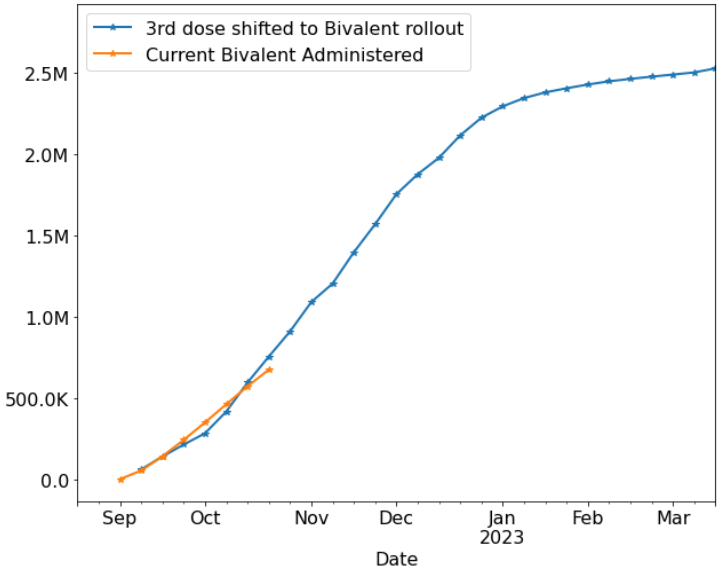
- Assuming Vax efficacy for BA.4/5 and previous variants is 80% against symptomatic illness
- Campaign follows current ground truth to present
- Variant X has same immune escape to these vaccines as against BA.5 (33%)

Current pace: Follows 3rd dose rollout, but maintains current pace relative to it (eg if slower, same slower rate continues into future)

Optimistic pace: 25% higher than previous 3rd dose schedule

No More: No further Bivalent boosters administered



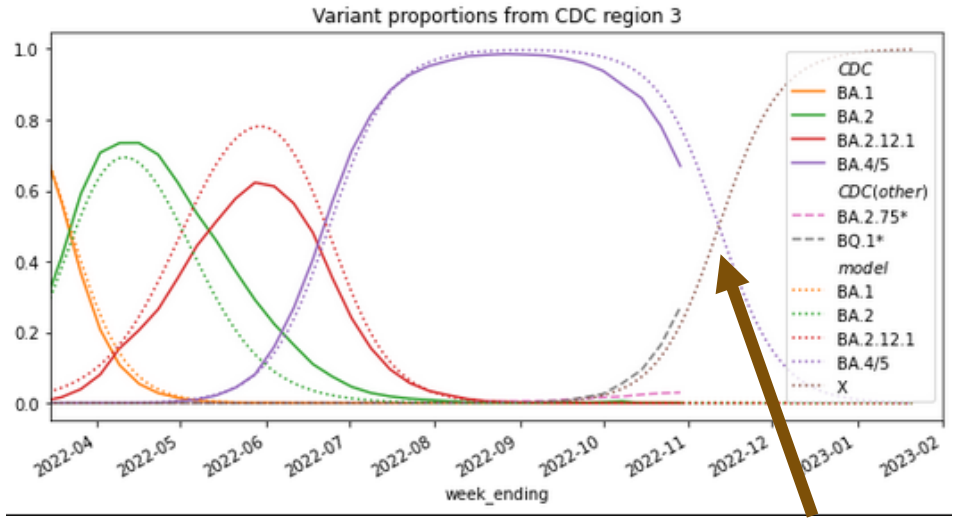


Scenarios – Variant X

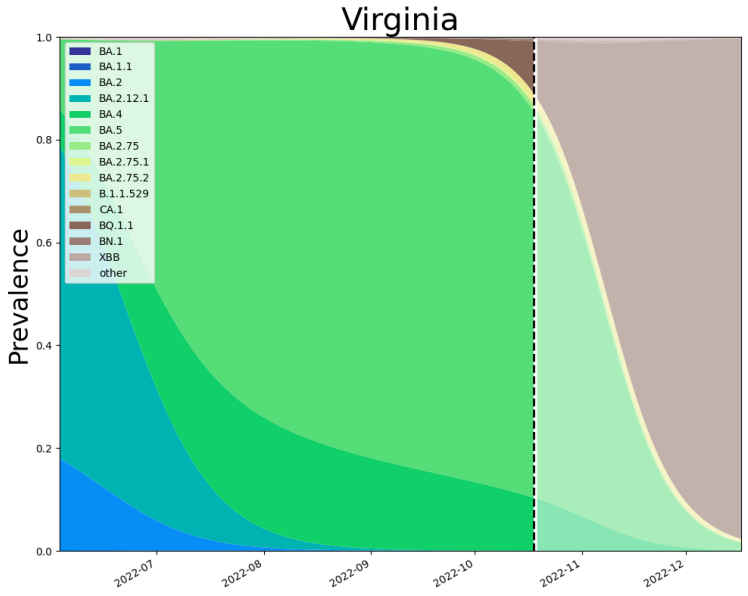
Omicron sub-variants seem to be emerging and then dominating with some regularity

- An increasingly complex soup of variants with demonstrated growth advantages in other countries and states continues to grow
- BQ.1.1, XBB, and others have shown evidence of significant immune escape, BQ.1.1 currently growing quickly in US and VA, it remains possible that several may simultaneously expand
- **VariantX** represents the next variant or the potential swarm of several. We assumes similar growth and level of immune escape against previous sub-variants as BA.4/5 (same transmissibility and 30% immune escape against BA.4/5, higher for other sub-variants).

Sub-Variants with Fitted Prevalences and Hypothetical Future waves



Variant X reaches 50% on Nov 12th



Projection Scenarios – Combined Conditions

Name	Txm	Variant	Booster	Description
Adaptive	C	SQ	Current	Likely trajectory based on conditions remaining similar to the current experience, includes immune escape due to Omicron
Adaptive-FallWinter	FallWinter	SQ	Current	Like Adaptive, with seasonal forcing of FallWinter added on
Adaptive-VariantX	C	X	Current	Like Adaptive, with emergence of a speculative unknown variant 4 months after BA.4/5 with similar level of immune escape and equal transmissibility
Adaptive-VariantX-FallWinter	FallWinter	X	Current	Like Adaptive-VariantX but with the seasonal force of FallWinter added on
Adaptive-VariantX-FallWinter-OptBooster	FallWinter	X	Optimistic	Like Adaptive-VariantX-Fall Winter but with Optimistic Booster (25% more than 3rd dose rollout)
Adaptive-VariantX-FallWinter-NoMoreBooster	FallWinter	X	No More	Like Adaptive-VariantX-FallWinter but with no additional Booster doses

Transmission: C = Current levels persist into the future
FallWinter = Transmission rates learned from Sept through February of past seasons are estimated and added as a seasonal boosting to baseline transmission rates

Variant: SQ = Status quo prevalences remaint the same (e.g. no significant major driving of transmission anticipated)
X = Novel sub-variant scenario, new variant emerges reaches dominance in near term, 30% immune escape

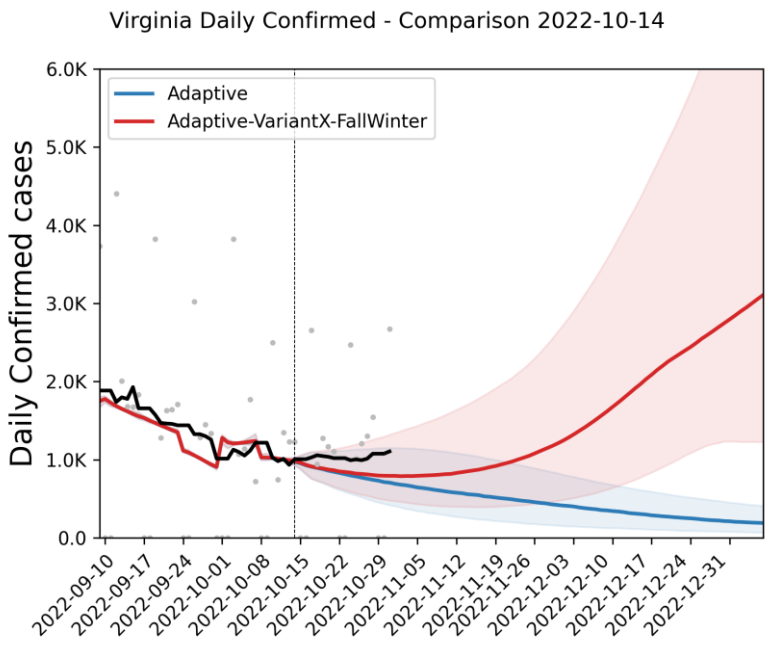
Booster: Current = Current pace relative to 3rd dose rollout is maintained in the future
Optimistic = Starting this week, additional 25% over the 3rd dose rollout is maintained into the future
No More = Starting this week, no additional doses of the booster are administered

Model Results

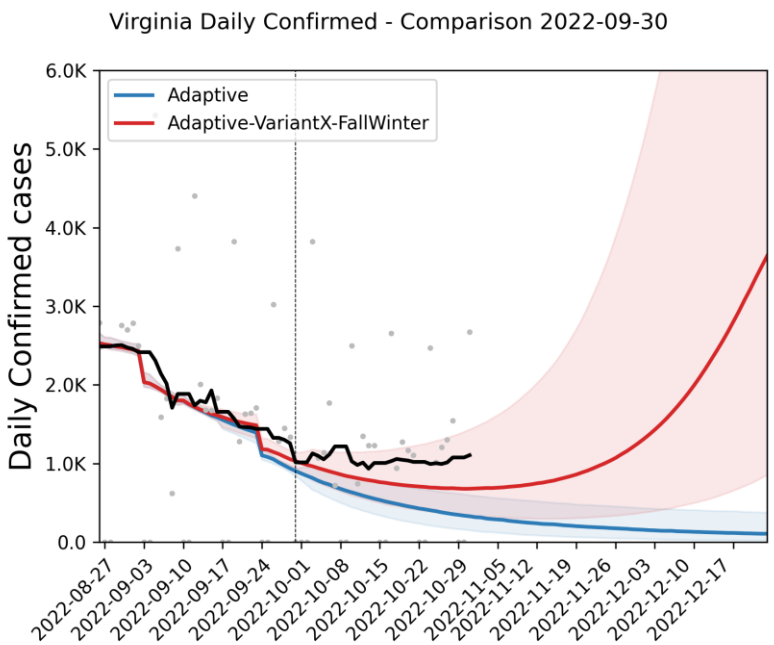
Previous projections comparison - Cases

- Previous projections continue to track observed cases
- Projection from 2 weeks ago projected plateau a week after cases started to plateau
- Projection from 4 weeks ago projected slower decline better capturing recent slowing
- Projection from early July remains eerily on track

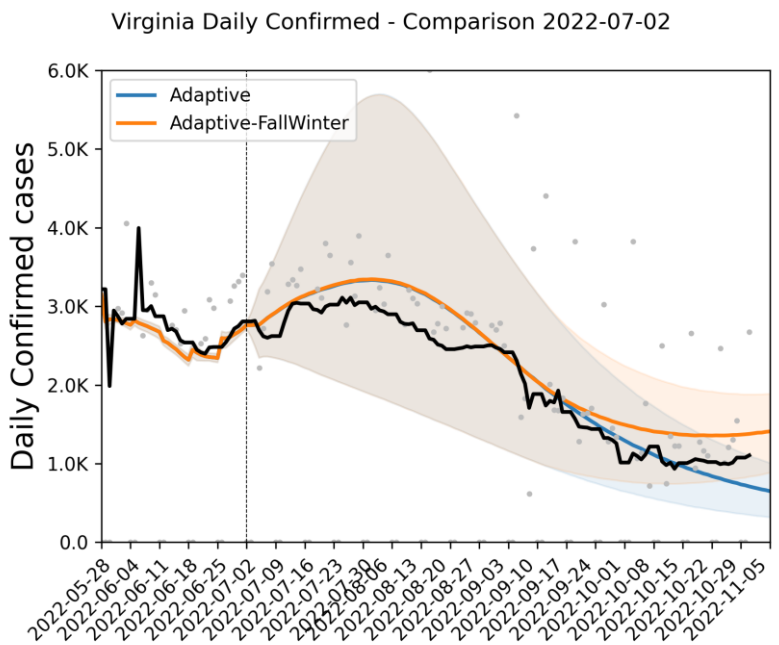
Previous round (2 weeks ago)



Projection from 4 weeks ago



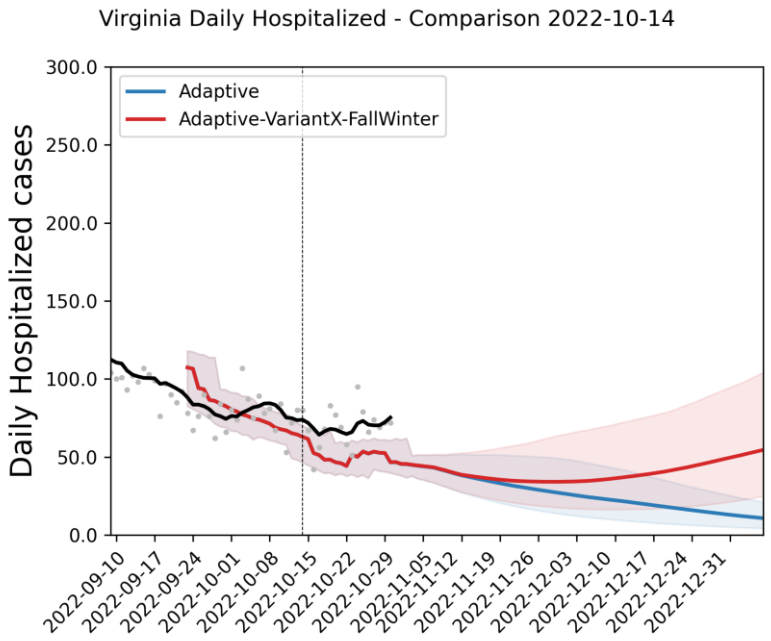
Projection from 3 months ago



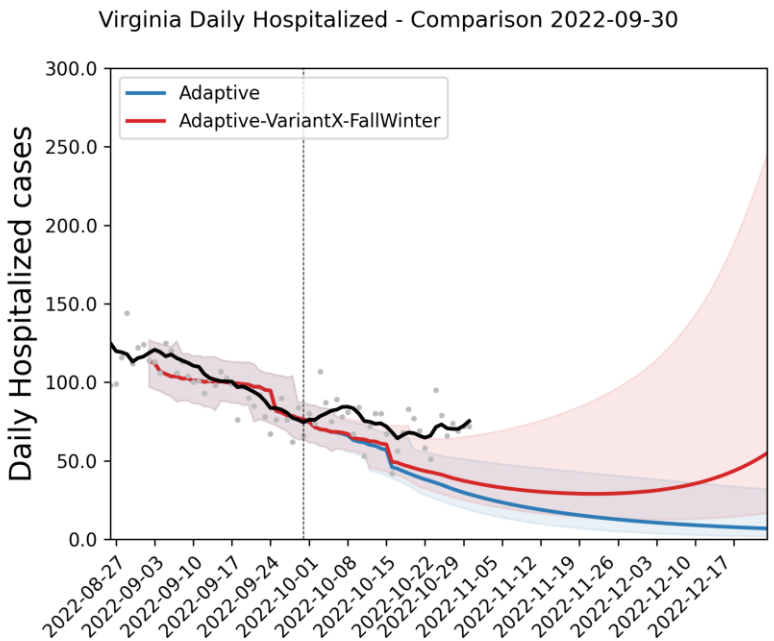
Previous projections comparison - Hospitalizations

- Previous projections have tracked observed hospitalizations well
- Projection from 2 weeks ago projected continued decline, missed bump
- Projection from early July anticipated a plateau has tracked reasonably well up to present

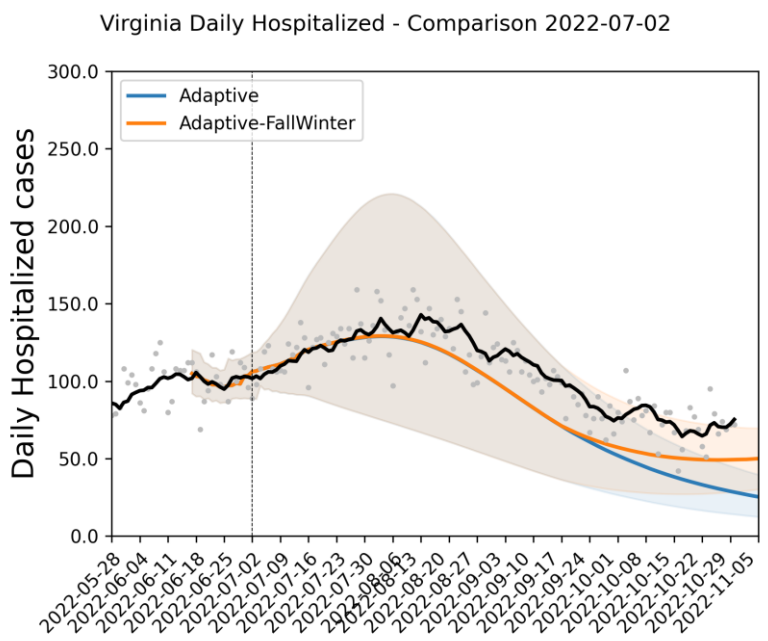
Previous round (2 weeks ago)



Projection from 4 weeks ago

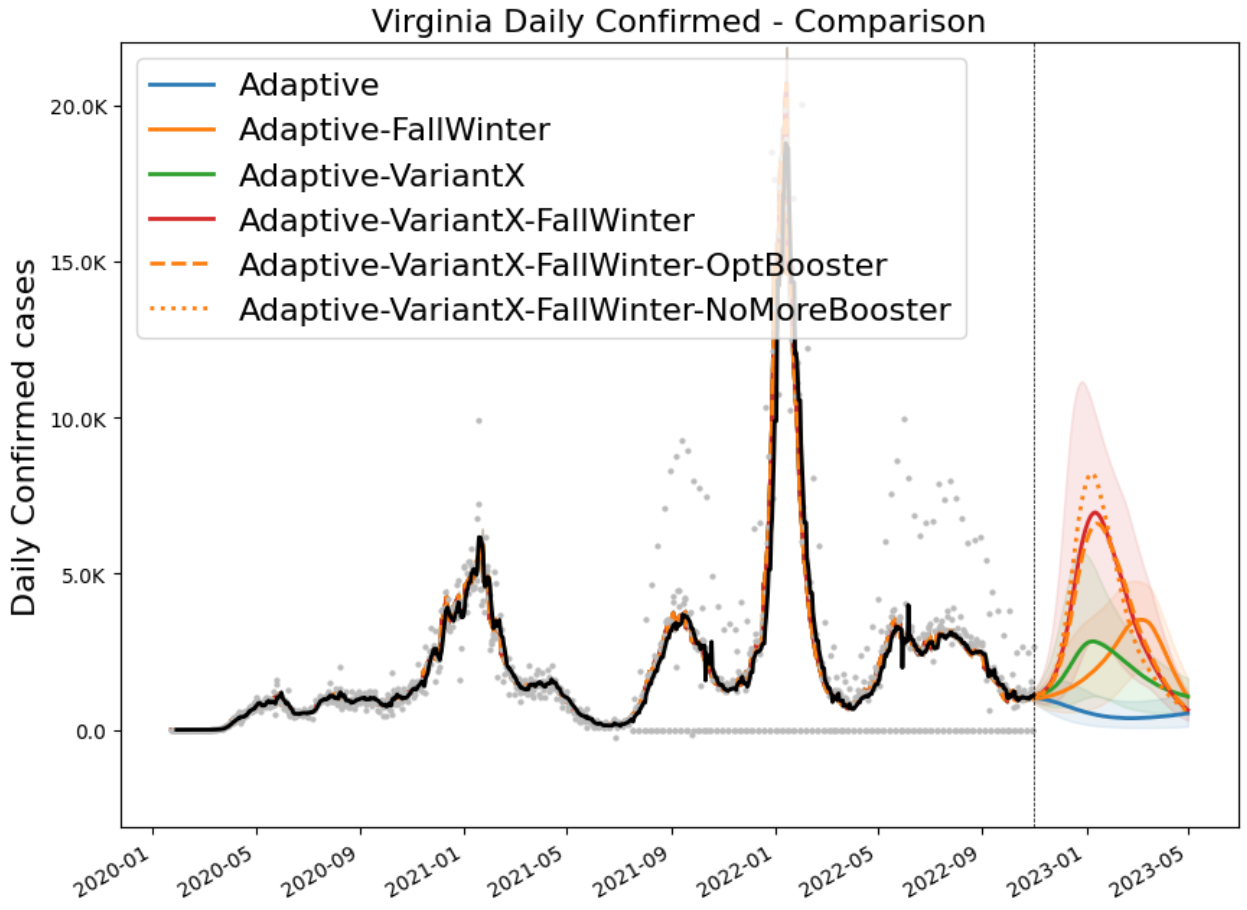


Projection from 3 months ago



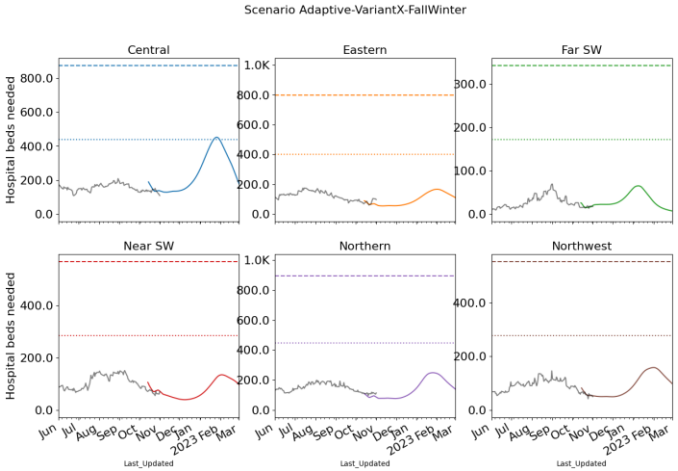
Outcome Projections

Confirmed cases

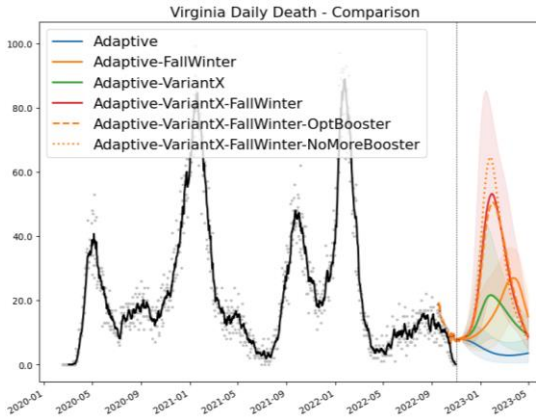


* without surveillance correction VariantBA2 peaked over 10K in July

Estimated Hospital Occupancy

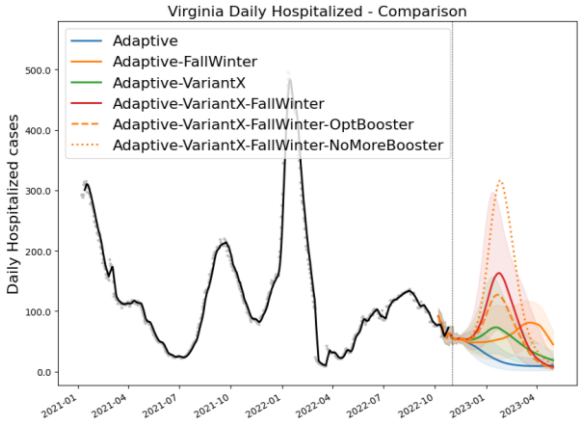


Daily Deaths



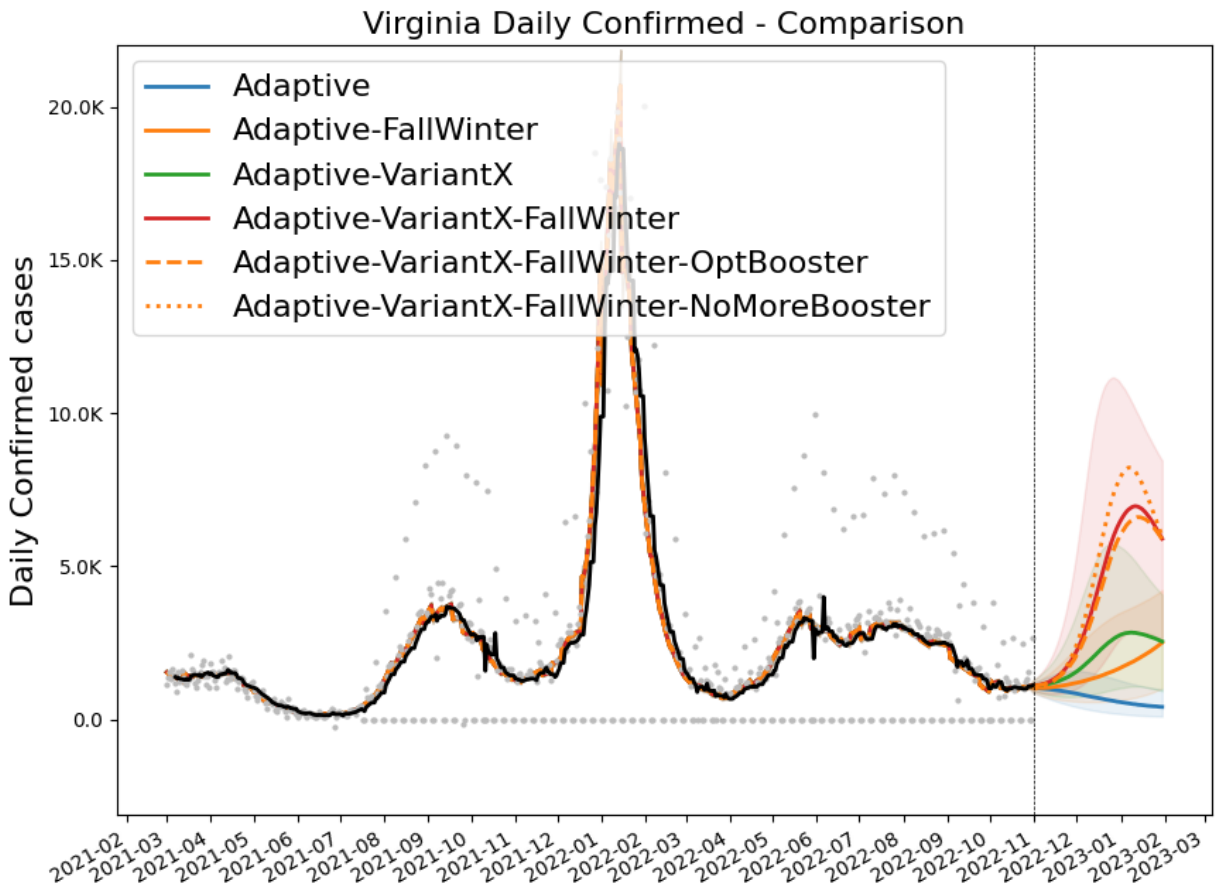
Death ground truth from VDH "Event Date" data, most recent dates are not complete

Daily Hospitalized



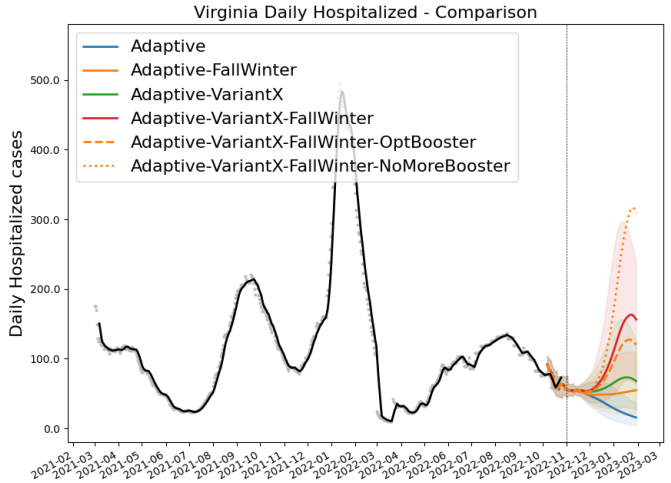
Outcome Projections – Closer Look

Confirmed cases

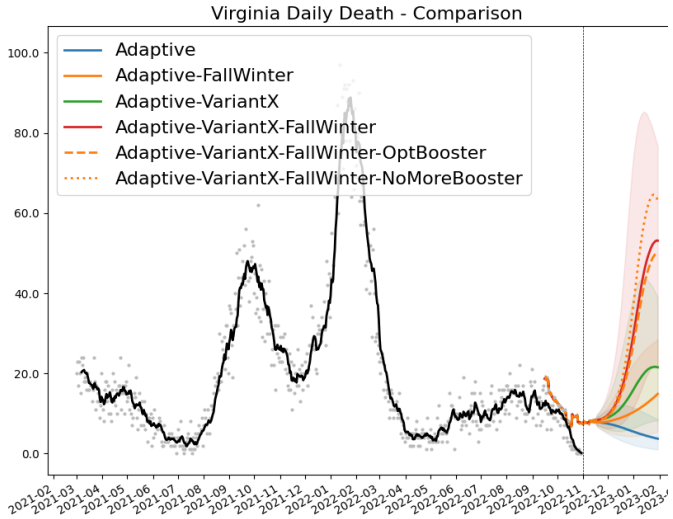


* without surveillance correction VariantBA2 peaked over 10K in July

Daily Hospitalized



Daily Deaths



Death ground truth from VDH "Event Date" data, most recent dates are not complete

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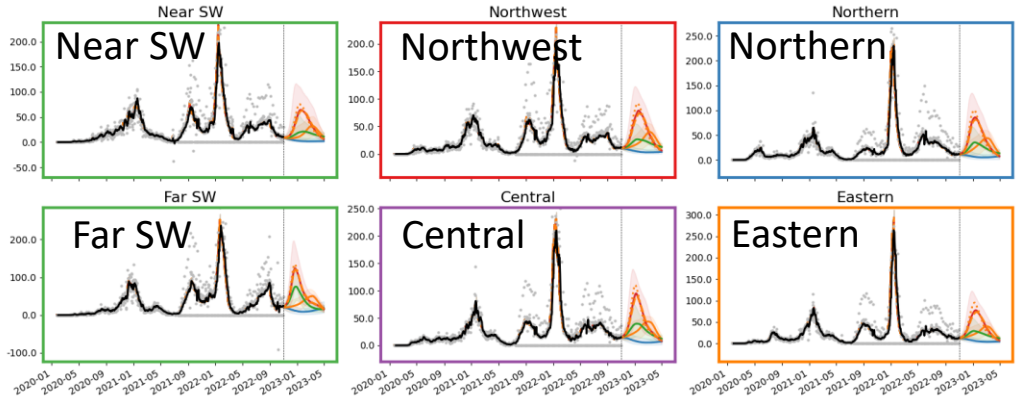
Detailed Projections: Cases for All Scenarios

Projections by Region

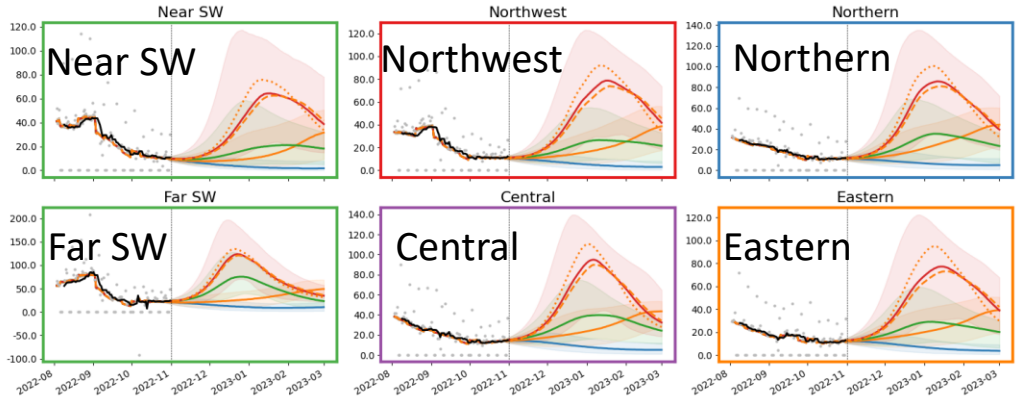


Projections by District

Daily confirmed cases) by rate (per 100K) District (grey with 7-day average in black) with simulation colored by scenario

Detailed Projections: Cases for All Scenarios - Closer Look

Projections by Region

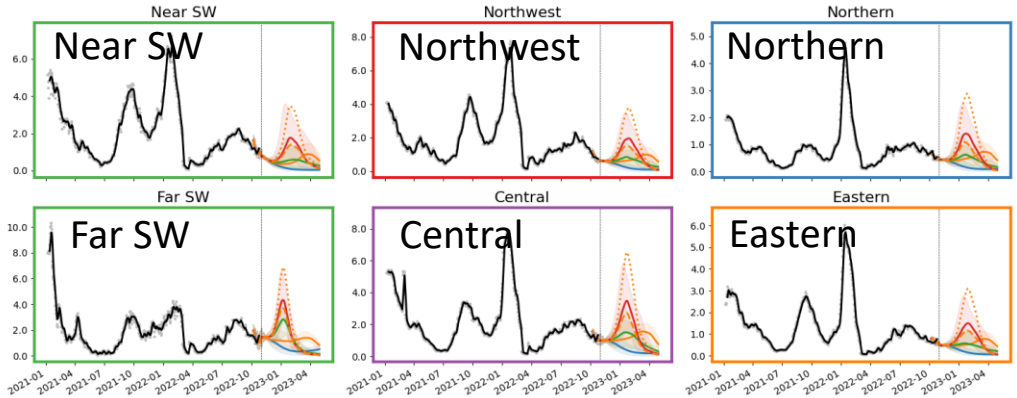


Projections by District

Daily confirmed cases by rate (per 100K) District (grey with 7-day average in black) with simulation colored by scenario

Detailed Projections: Hospitalizations for All Scenarios

Projections by Region

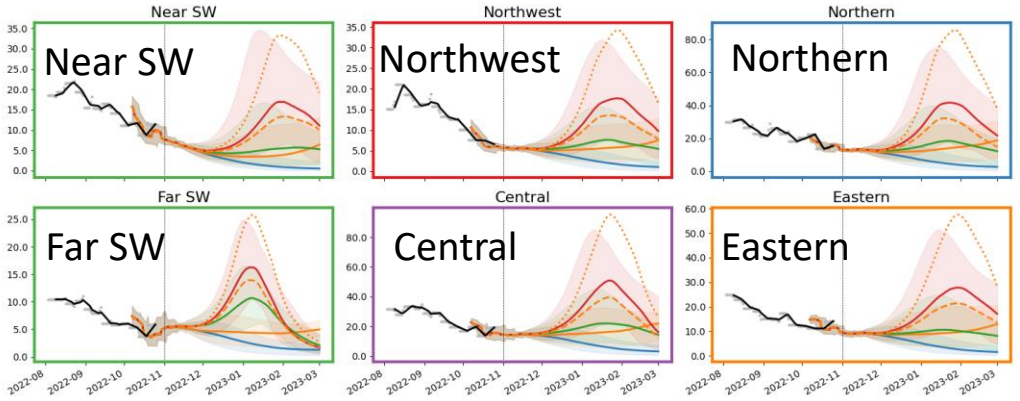


Projections by District

Daily confirmed hospitalizations District (grey with 7-day average in black) with simulation colored by scenario

Detailed Projections: Hosps for All Scenarios - Closer Look

Projections by Region



Projections by District

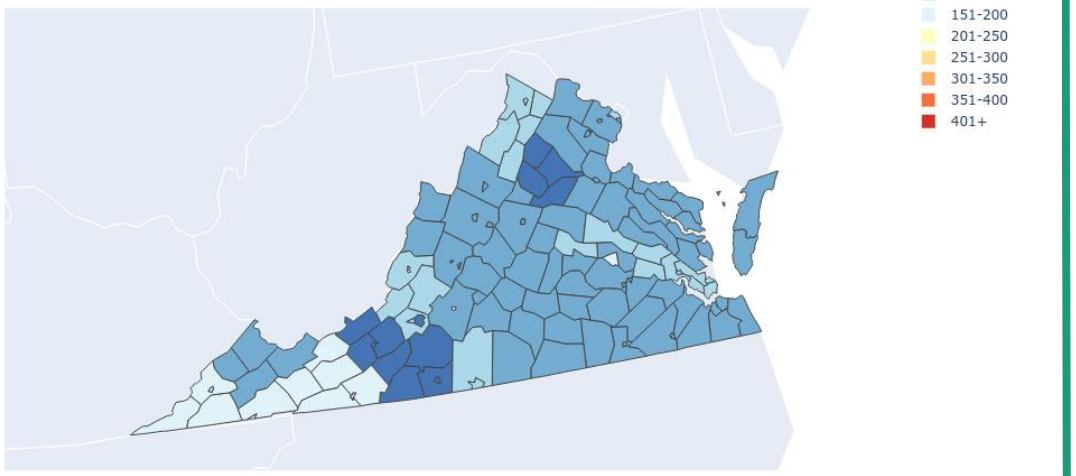
Daily confirmed hospitalizations District (grey with 7-day average in black) with simulation colored by scenario

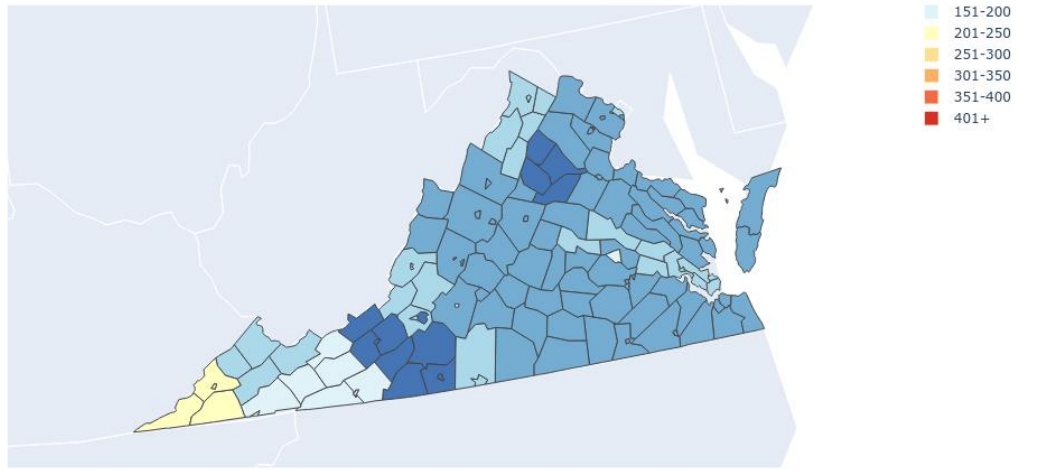
Adaptive

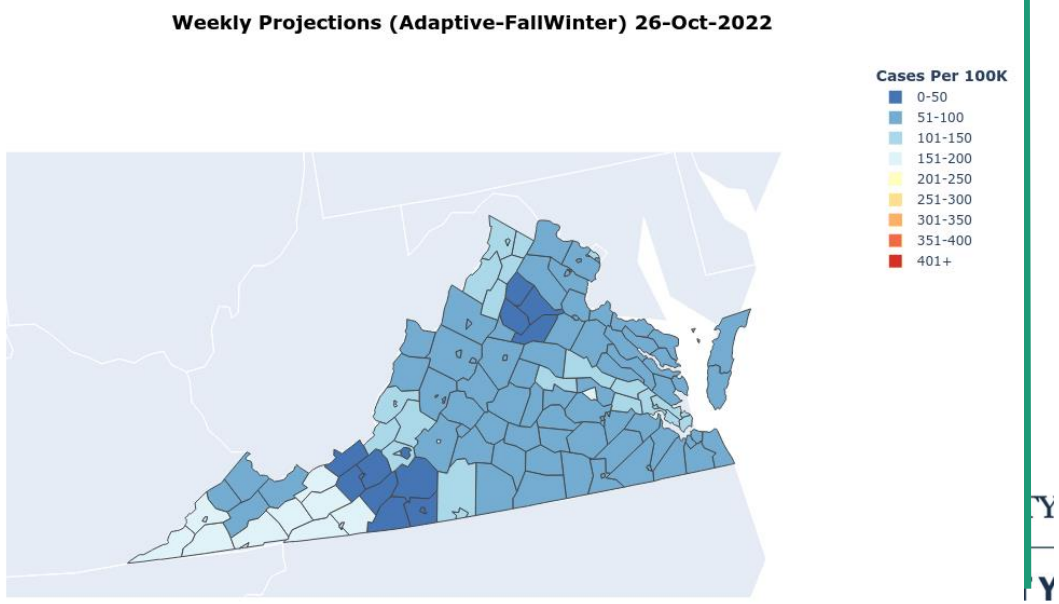
VariantX

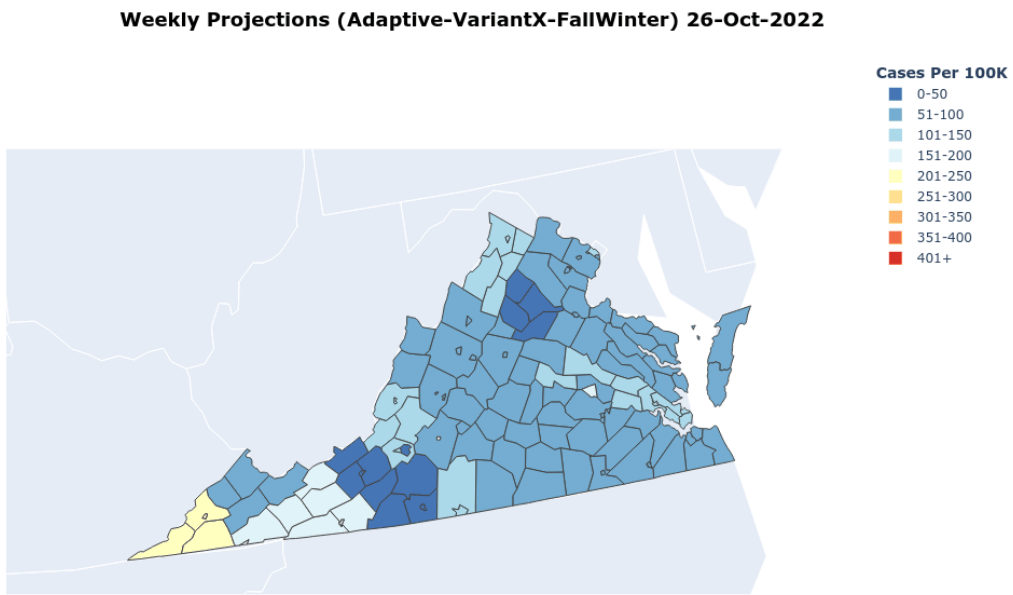
Adaptive

Adaptive-Fall-Winter

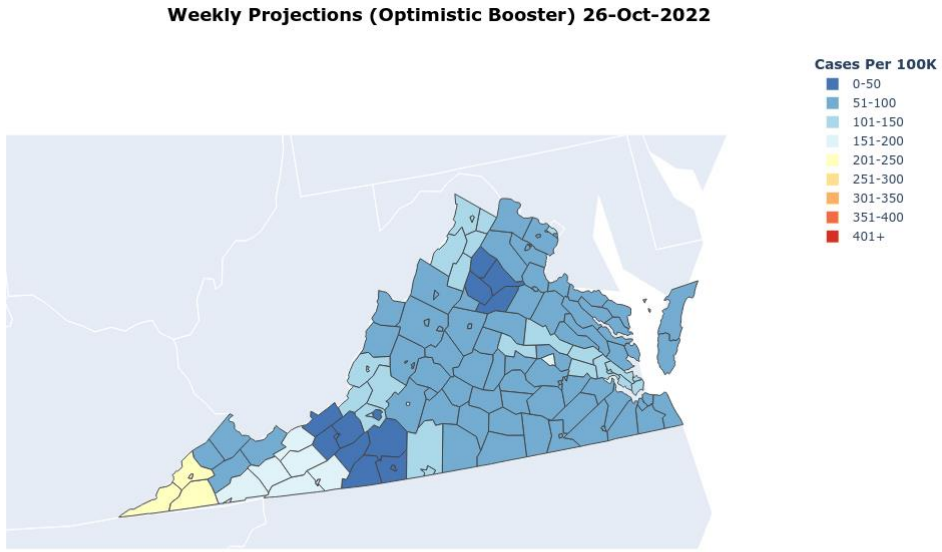


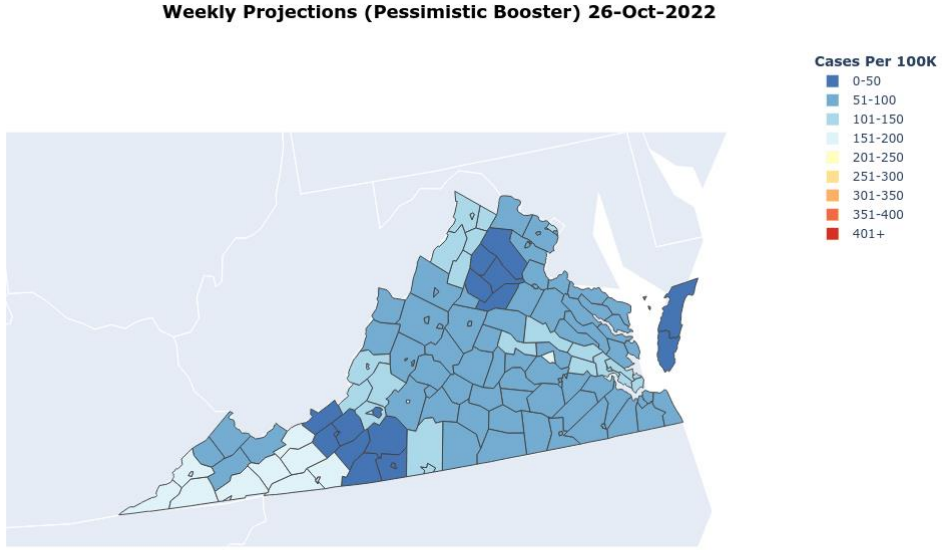


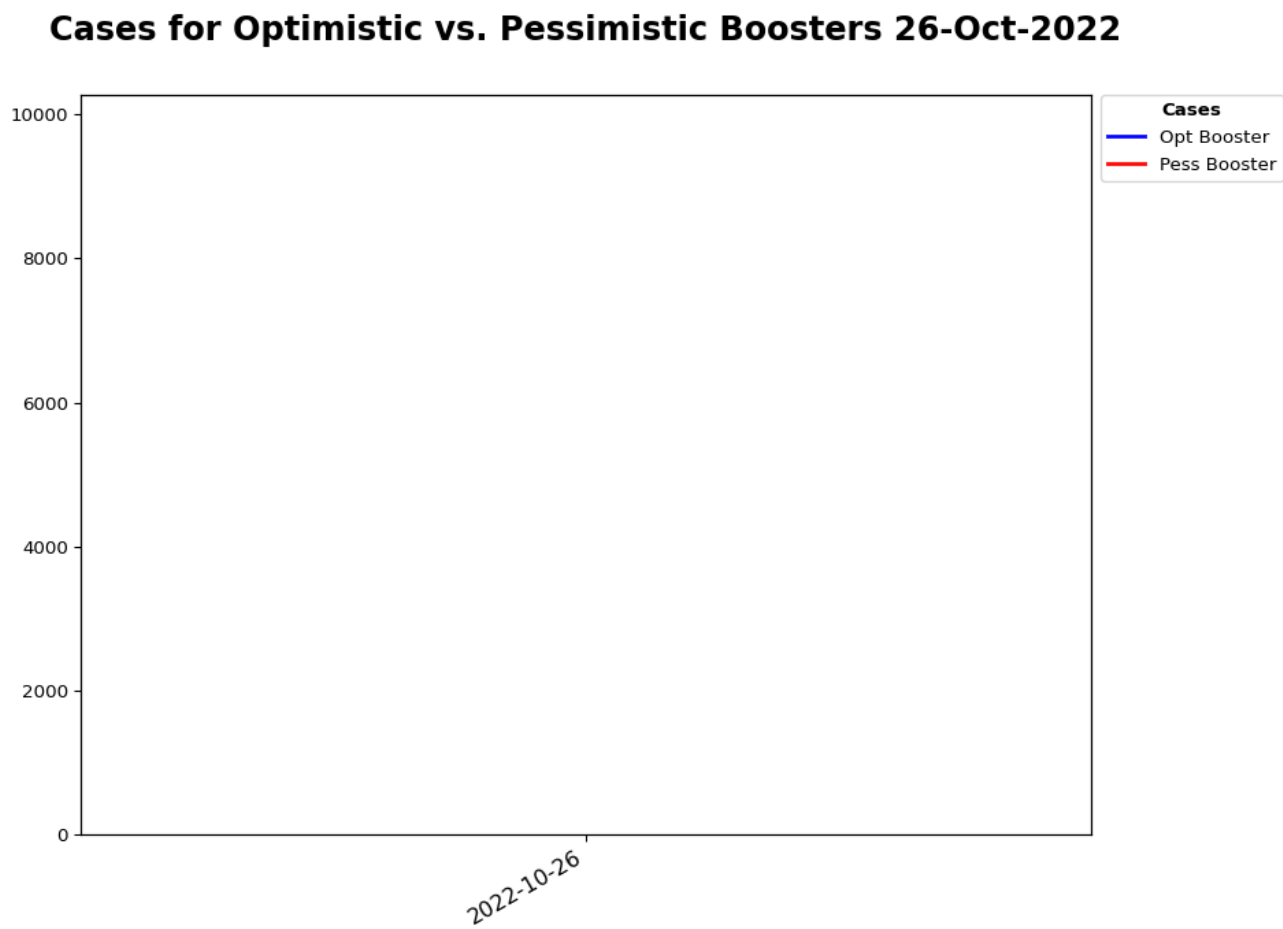




Impact of Optimistic vs. Pessimistic Booster Distribution



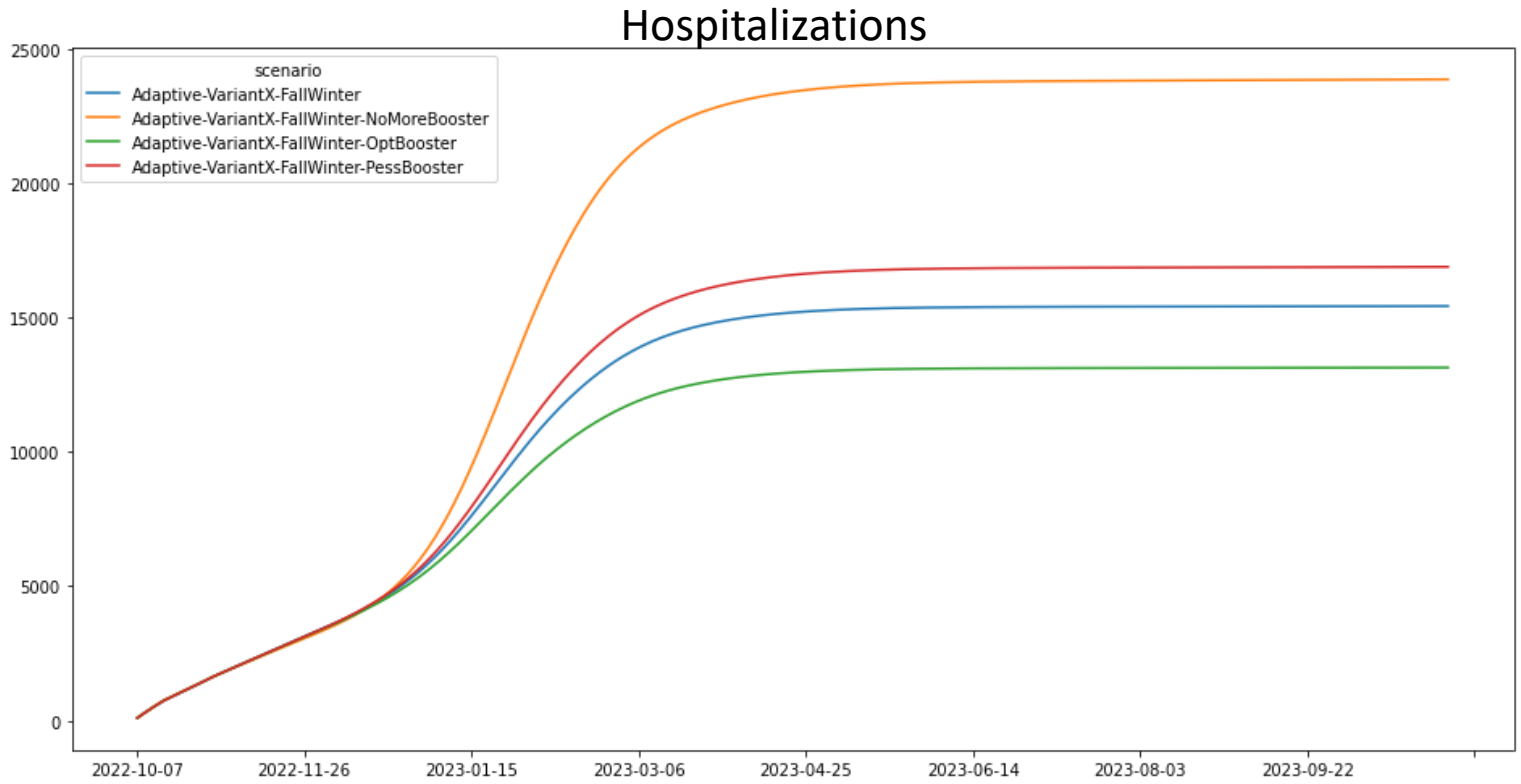




Booster Campaign Coverage has impact on future hospitalizations

Booster Campaign can significantly limit future hospitalizations and severe outcomes

- Optimistic scenario (higher coverage) shows potential to avert ~2000 hospitalizations
- No More Booster scenario shows additional ~8.5K hospitalizations should booster administrations halt at current levels



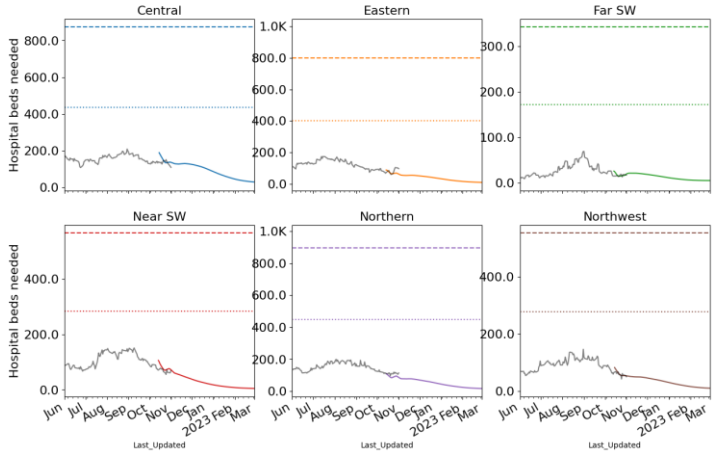
This is despite a VariantX emerging that has demonstrated immune escape (30%) against the bivalent booster in near term

Hospital Demand and Bed Capacity by Region

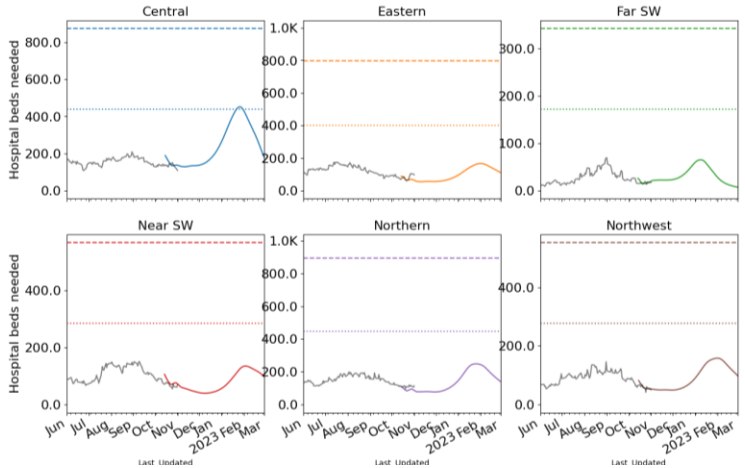
Capacities by Region

COVID-19 capacity ranges from 80% (dots) to 120% (dash) of total beds

Adaptive



Adaptive – VariantX & Fall Winter



Length of Stay more variable with Omicron, occupancy projections may vary as a result, ad-hoc estimation performed per region

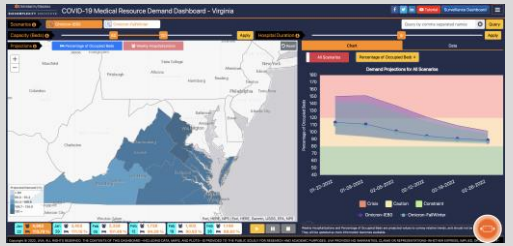
Estimated LOS shortened slightly to better fit observed data

Projections show continued declines and with expanded capacities and adjusted length of stay, no capacities exceeded

Length of Stay Estimates

Central	8
Eastern	6
Far SW	4
Near SW	9
Northern	5
Northwestern	9

Interactive Dashboard with regional projections



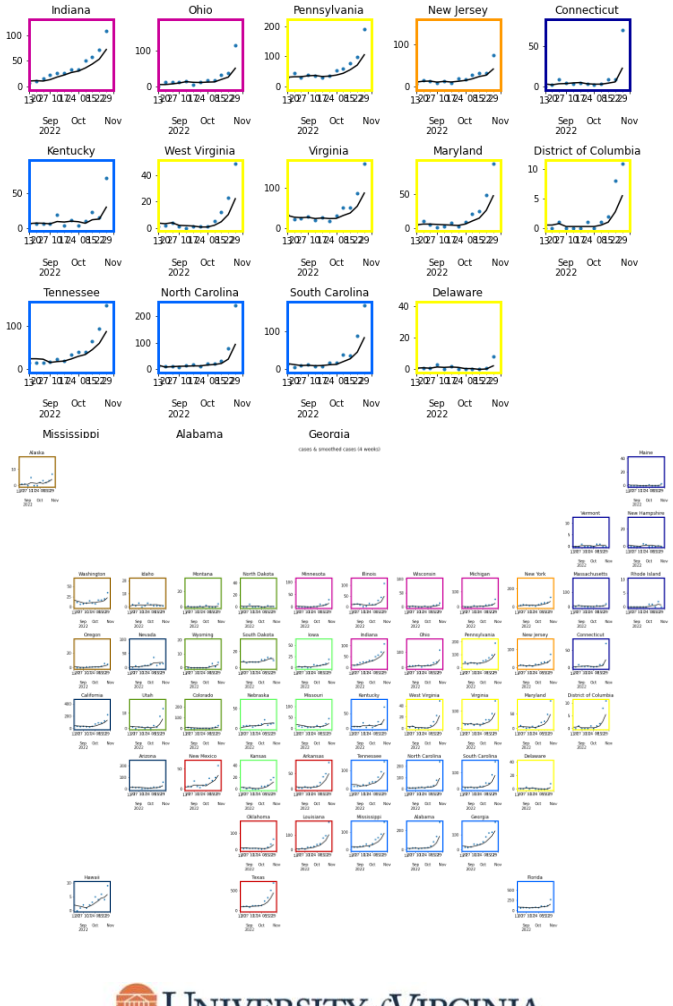
https://nssac.bii.virginia.edu/covid-19/vmrddash/

Current Influenza Situation

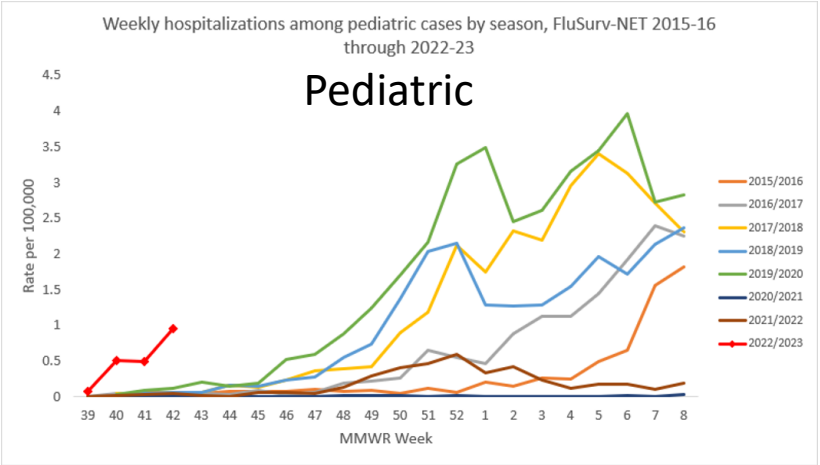
Influenza Cases and Activity are Higher than Usual

- Highest hospitalization rate for this time of year in past 8 years
- Significant changes in hospitalizations in last 2 weeks especially in Southern and Eastern states
- ILI activity significantly higher than previous seasons, concentrated in South and East

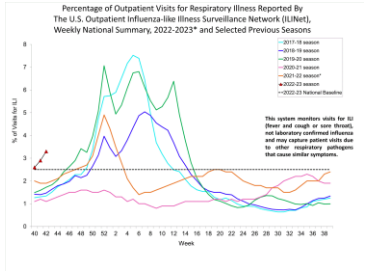
Influenza Hospital Admissions (HHS Protect)

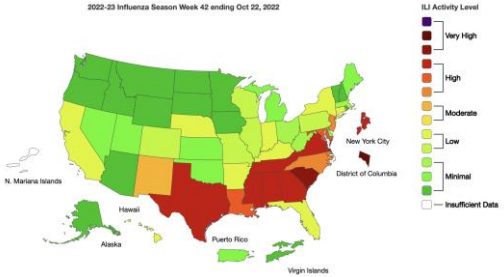


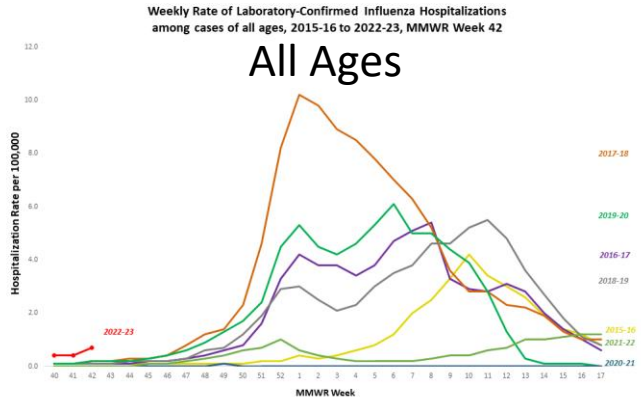
Influenza Hospitalization Rates (FluSurv-NET)



Influenza-Like Illness Activity (ILI Net)







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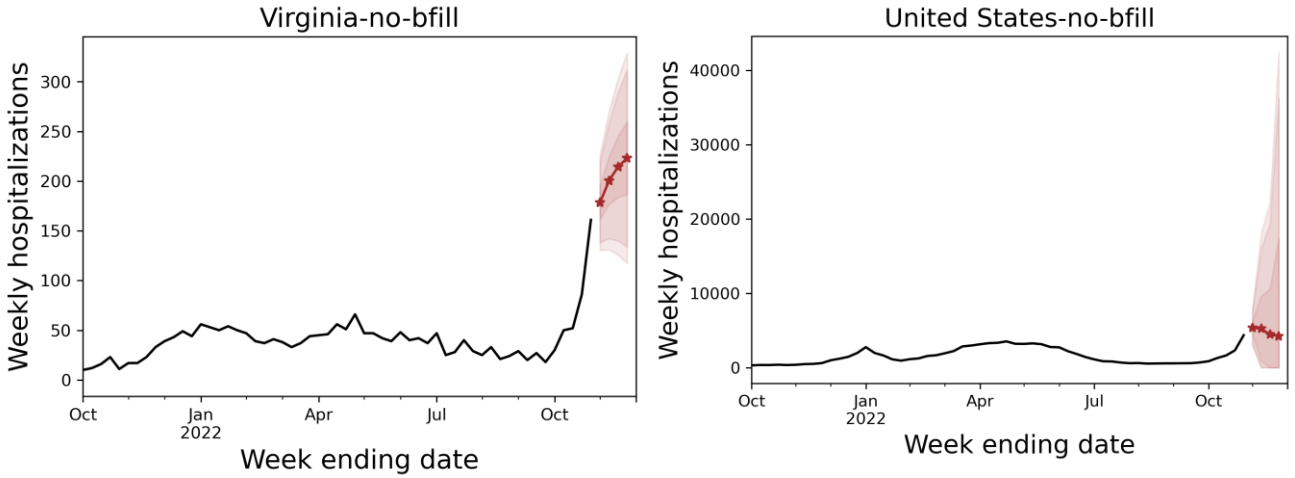
Current Influenza Hospitalization Forecast

Statistical models for submitting to CDC FluSight forecasting challenge

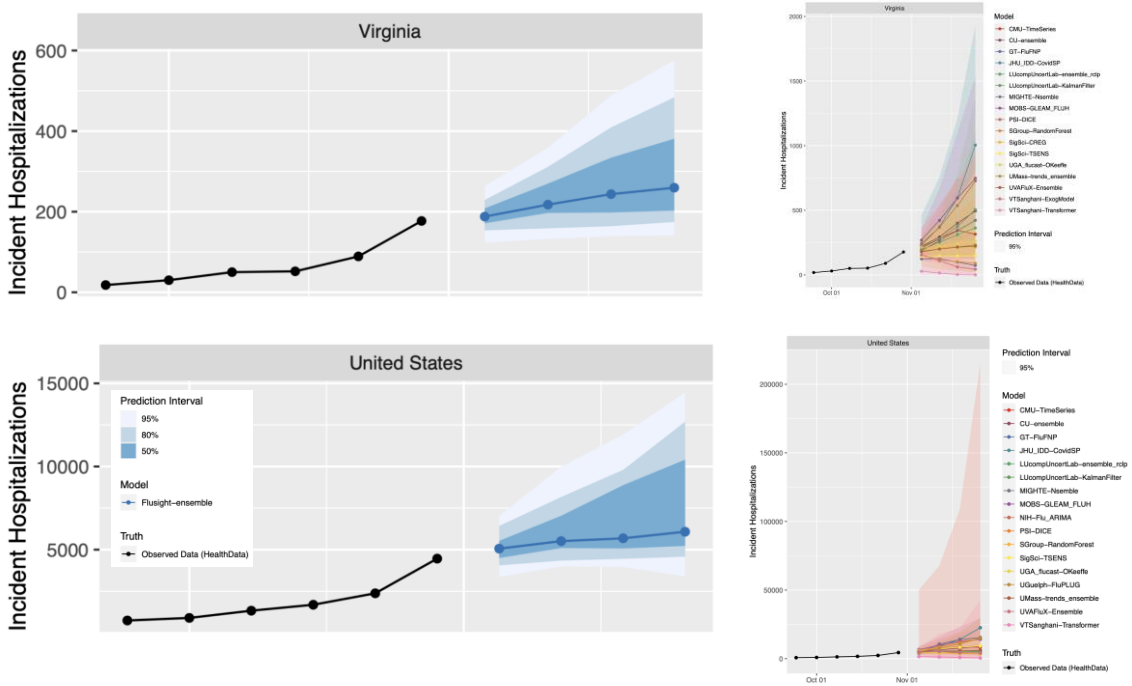
- Similar to COVID-19 case forecasts, uses a variety of statistical and ML approaches to forecast weekly hospital admissions for the next 4 weeks for all states in the US

Hospital Admissions for Influenza and Forecast for next 4 weeks (UVA ensemble)



Initial forecasts have wide uncertainty due to earliness of the season and limited training data with “sharp rises”

Hospital Admissions for Influenza and Forecast for next 4 weeks (CDC FluSight Ensemble)



Some individual models forecast rapid rises in VA

CDC FluSight

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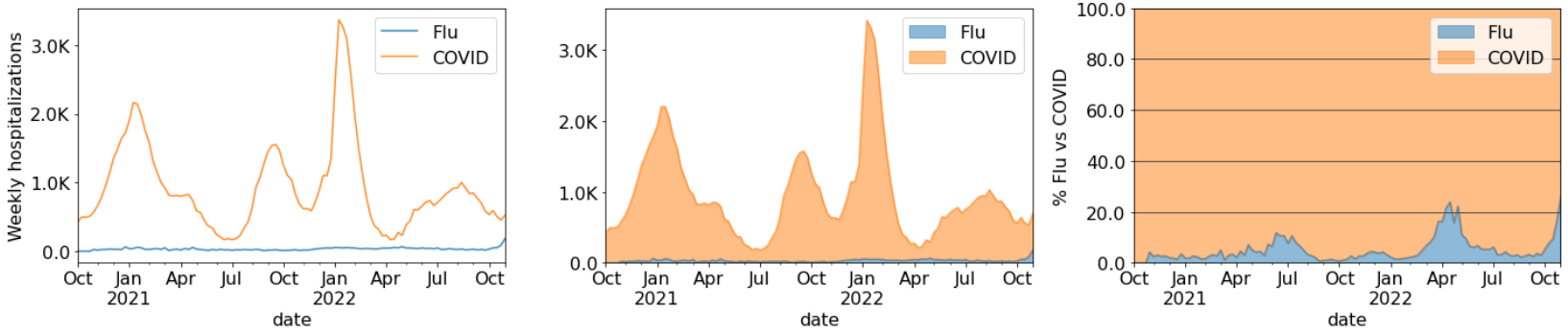
Current Combined Hospitalizations (COVID-19 & Influenza)

COVID-19 and Influenza Weekly Hospitalizations (HHS Protect)

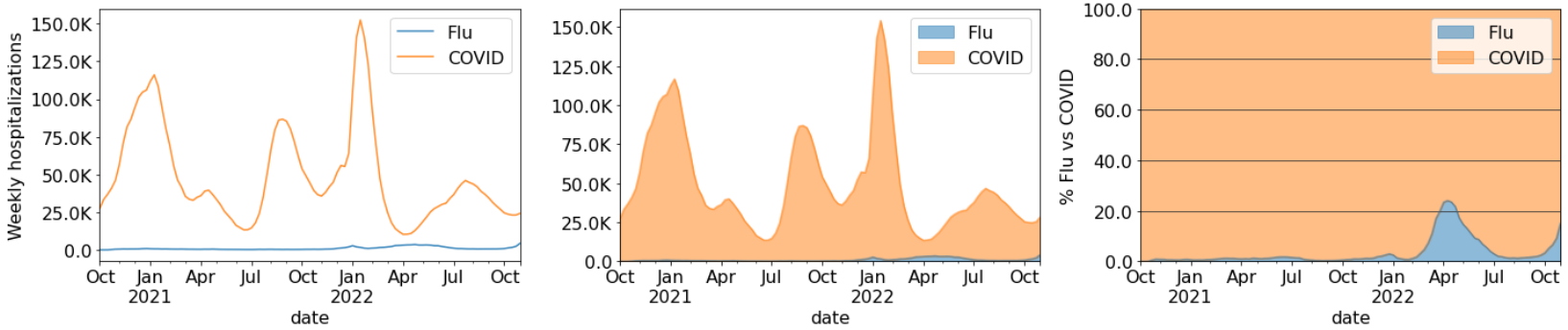
Virginia

Virginia Flu and COVID hospitalizations

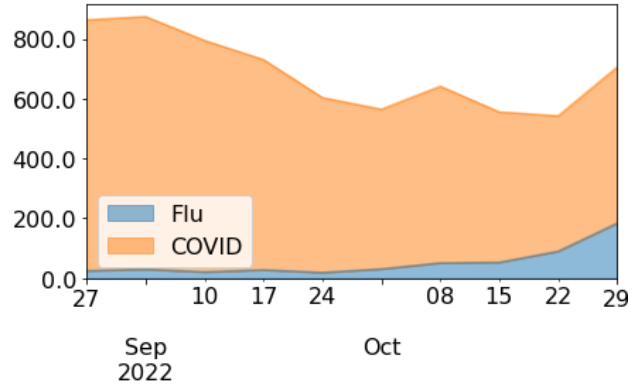


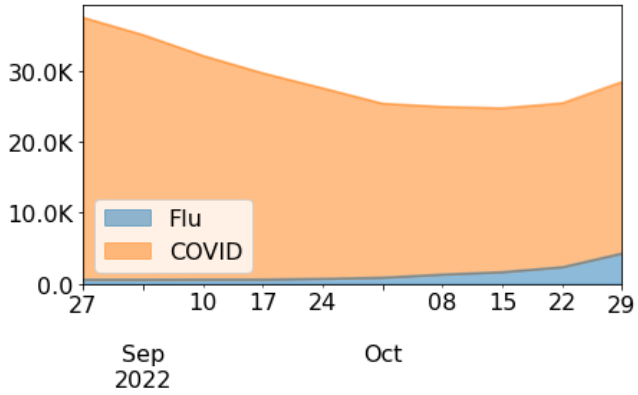
USA

National Flu and COVID hospitalizations



Recent Trend





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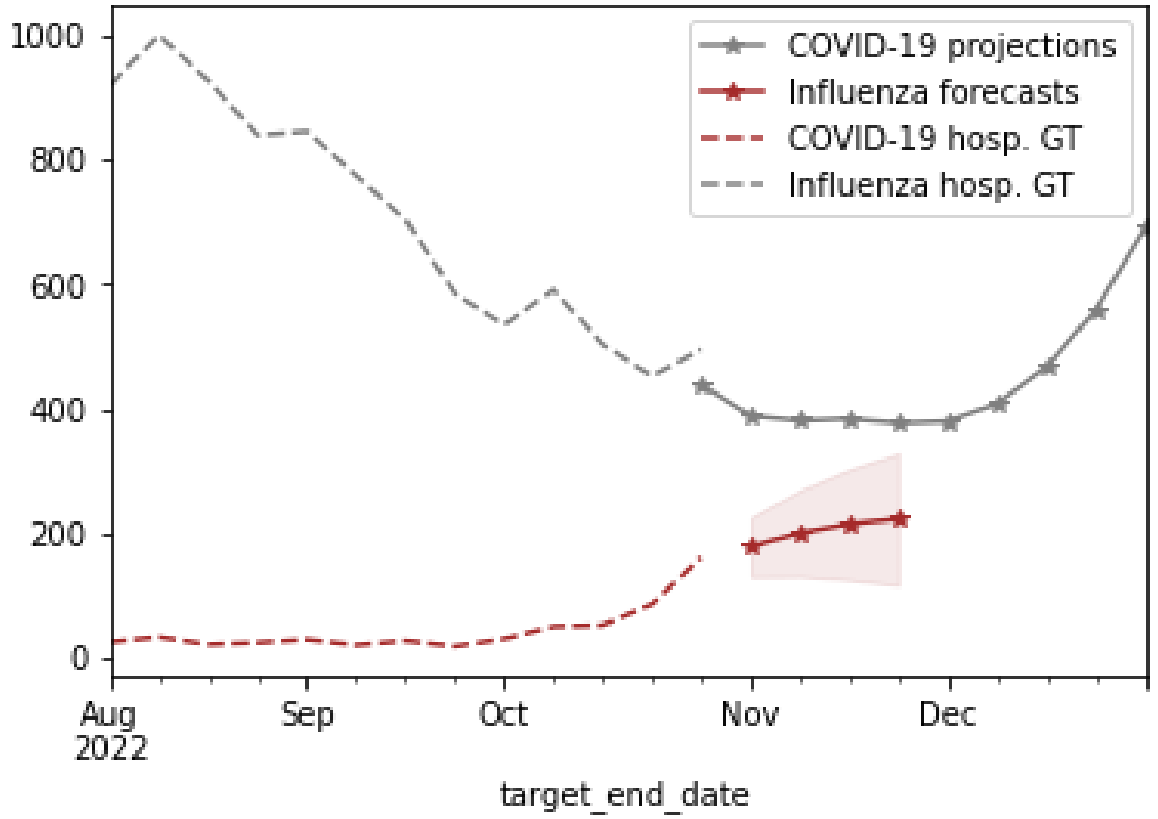
Combined Hospitalization Projections (COVID-19 & Influenza)

Weekly Hospitalizations
COVID-19 Projections and short-term Influenza Forecasts



Scenario Modeling Hub – COVID-19 and Influenza

Collaboration of multiple academic teams to provide national and state-by-state level projections for 4 aligned scenarios

- COVID-19 Scenarios

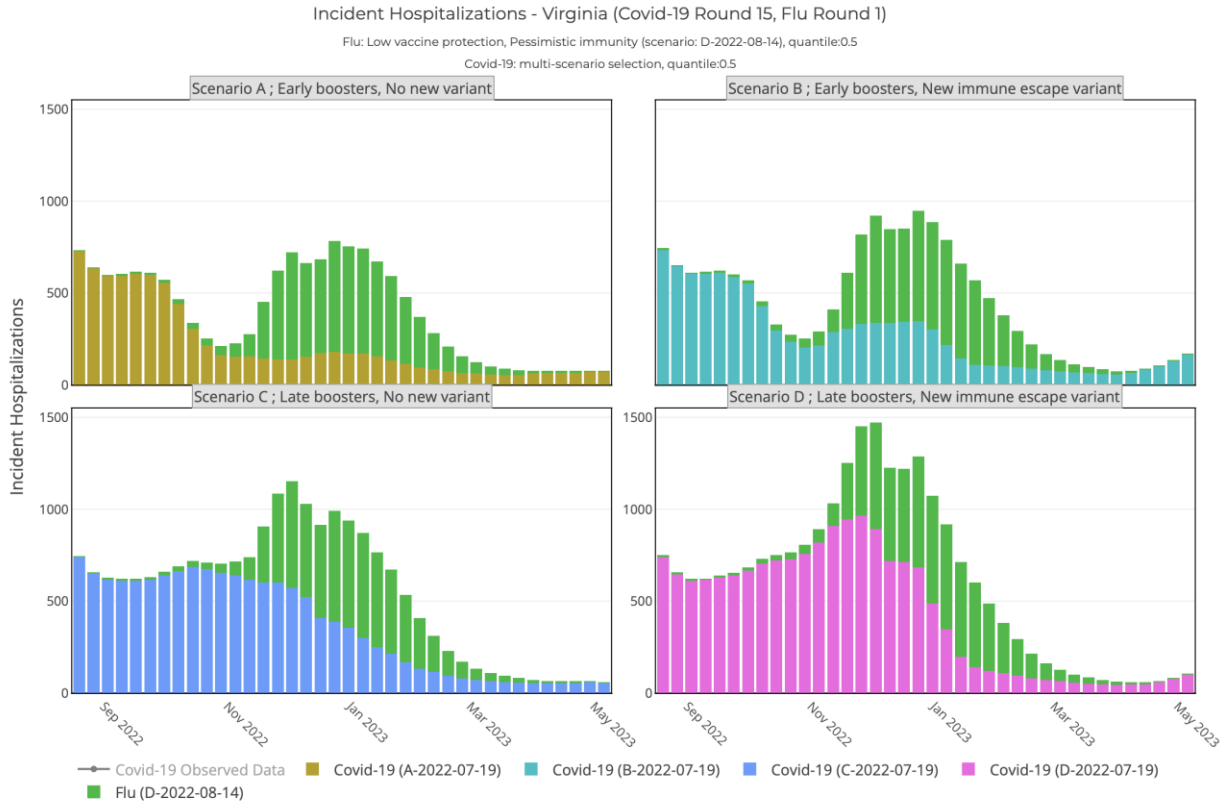
  - ☑ **Scenario A**
    Early boosters
    No new variant
    (A-2022-07-19)
  - ☑ **Scenario B**
    Early boosters
    New immune escape variant
    (B-2022-07-19)
  - ☑ **Scenario C**
    Late boosters
    No new variant
    (C-2022-07-19)
  - ☑ **Scenario D**
    Late boosters
    New immune escape variant
    (D-2022-07-19)

- Influenza Scenarios

  - ○ High vaccine protection, Optimistic immunity (A-2022-08-14)
  - ○ High vaccine protection, Pessimistic immunity (B-2022-08-14)
  - ○ Low vaccine protection, Optimistic immunity (C-2022-08-14)
  - ◉ Low vaccine protection, Pessimistic immunity (D-2022-08-14)

Round 16 of COVID-19 in progress, Round 2 of Influenza in planning stages; should be available by Thanksgiving

Combined Hospitalizations (VA)
Interactive visualization – MultiPathogen Plot
https://covid19scenariomodelinghub.org/viz.html



COVID -19 scenarios and most “pessimistic” influenza scenarios combined

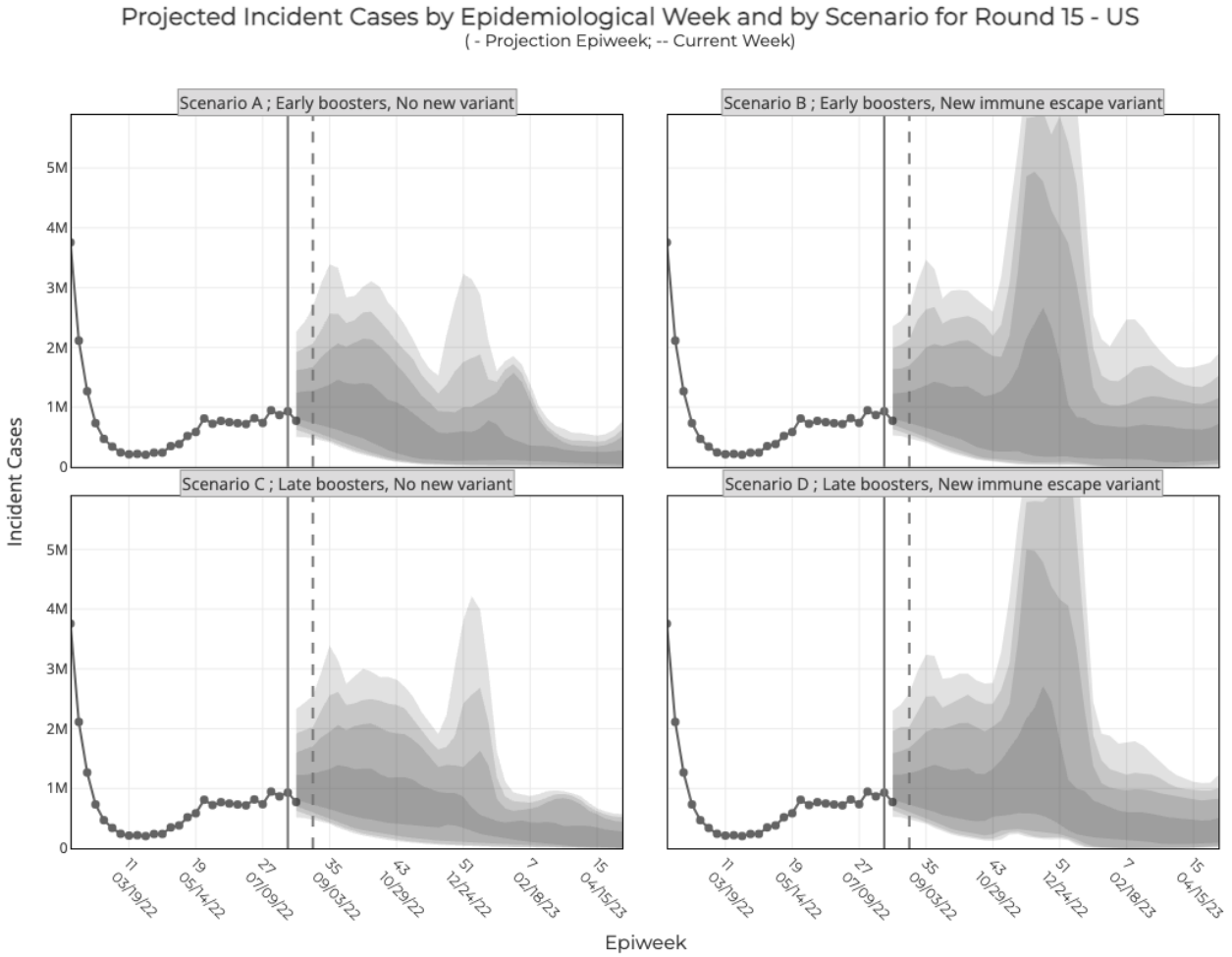
Scenario Modeling Hub – COVID-19 (Round 15)

Collaboration of multiple academic teams to provide national and state-by-state level projections for 4 aligned scenarios

- Round 15 results published
  - Scenarios: Test benefits of reformulated fall boosters w/ and w/out a new variant
  - Timing of reformulated boosters is one of the axes

Round 16 in progress stages should be available by mid/late-November

https://covid19scenariomodelinghub.org/viz.html

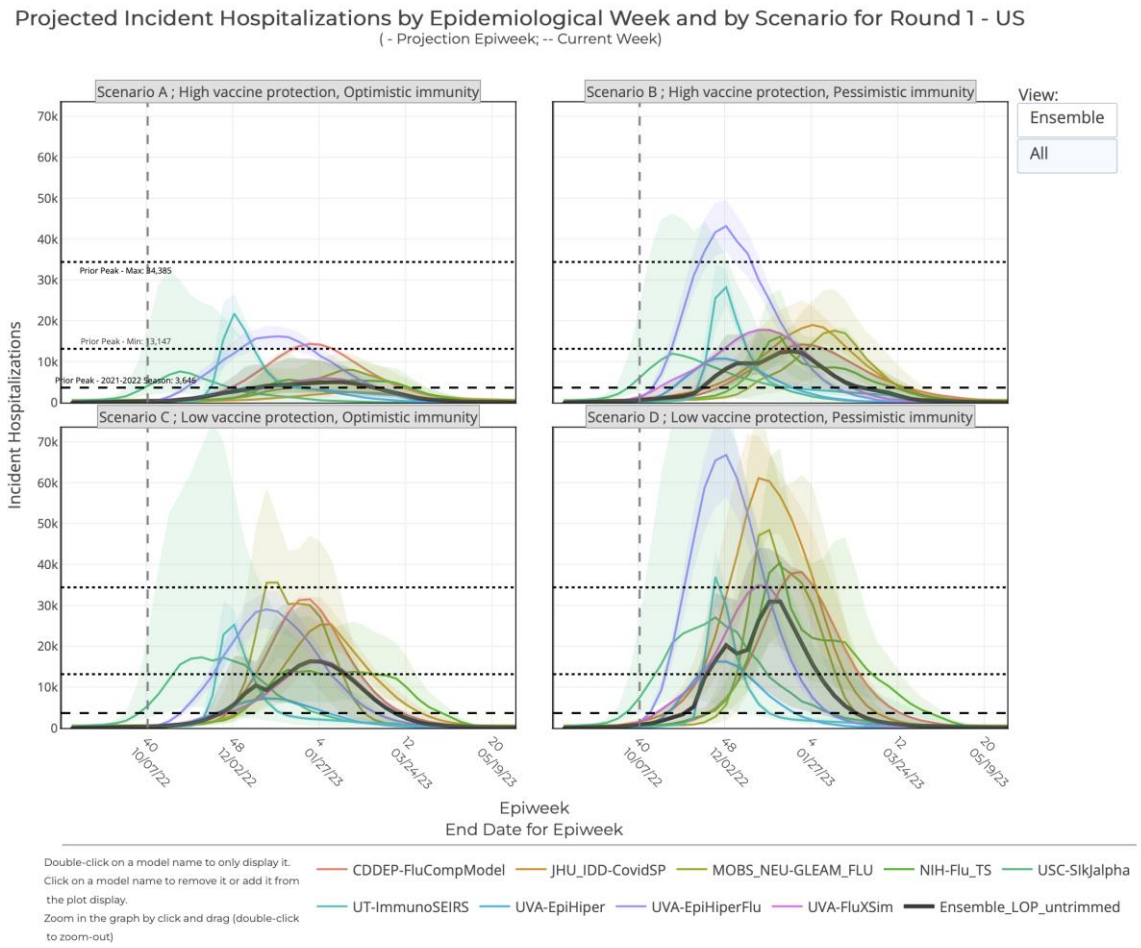


Scenario Modeling Hub – Influenza (Round 1)

Collaboration of multiple academic teams to provide national and state-by-state level projections for 4 aligned scenarios

- Round 1 results recently published
  - Impact of missed flu seasons on pre-season immunity
  - Testing different seasonal vaccine coverage and efficacy
  - Projected from Aug 14th 2022
- High degree of uncertainty as previous 2 seasons have been irregular and there is still limited data for this season available
- Demonstrates importance of good vaccine coverage especially if previous immunity is weak

https://fluscenariomodelinghub.org/viz.html



Key Takeaways

Projecting future cases precisely is impossible and unnecessary.
Even without perfect projections, we can confidently draw conclusions:

- **Case rates continue their decline, hospitalizations continue decline, though the rate of decline is slowing**
- VA weekly case rate is back up to 90/100K from 81/100K
  - US weekly case rate is flat remaining at 74 per 100K from 74 per 100K
- VA hospital occupancy (rolling 7 day mean of 472 also slightly up from 455 a week ago) has continued to decline
  - Influenza hospitalization shows a rapid increase with over 100 hospitalizations in the last week
- Projections anticipate continued plateau with increases in cases and hospitalizations in coming weeks
  - Rebounds due to seasonal forces and/or novel sub-variants in the coming months could be significant
- Model updates:
  - Modified Booster Scenarios: Current pace (included in all scenarios) with comparisons between Optimistic rollout and a more Pessimistic where vaccination halts at current levels
  - Variant X candidates seem to be growing (BQ.1.1 and XBB among others), 50% prevalence adjusted to Nov 12th

The situation continues to change. Models continue to be updated regularly.

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Google. COVID-19 community mobility reports. https://www.google.com/covid19/mobility/

Biocomplexity page for data and other resources related to COVID-19: https://covid19.biocomplexity.virginia.edu/

Questions?

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